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AT LAST!

THE anxiously-awaited report of Major Marindin is at last before the public, and its contents give ample food for reflection to both the electric lighting trade and to investors. We hail with genuine satisfaction the chance of doing real work now placed in the hands of the electric light companies, but "What will they do with it?"

There are at the present time, we regret to say, ominous signs in the electrical world of Stock Exchange speculation usurping the place of sound commercial progress, and doubtless one of the baits put before a gullible public will be this present evidence of a real intention to supply London with the new light, and as surely as we write, financial failure in any of these new undertakings will mean retrogression or stagnation far worse than we had from 1882 to 1887.

Major Marindin's report is most carefully thought out, as all parties who have followed the course of the investigation, and compared it with the report, will admit. The proposals, suggestions and statements of the various witnesses have been carefully weighed, and there is a total absence of bias, and an agreeable impartiality in the results arrived at; justice has been done to all, and the genuine supply companies have ample opportunity given them to work their systems under fair conditions. The provision that binds the various suppliers to "at once lay down mains in certain streets to be scheduled, and in other streets on requisition by owners or occupiers," is evidence that the Board of Trade thoroughly intends that actual work should be commenced forthwith; thus we shall be saved the phantom schemes that during the last few years have so irritated would be consumers who have been persuaded to lay out money in wiring their houses and buying expensive fittings on the promise of a supply of current which never comes.

The careful enquiry into the amount of capital at the disposal of the supply companies will also do great good, as it enables shareholders to estimate their chances of a return for their investment, and to know that their money is being placed in legitimate channels.

The consumer's interest is well looked after as regards the minimum annual amount he has to pay, and the resolution to fix a general price per unit of consumption will be of use in comparing the cost of production in the different systems. In the cases where two companies have powers over the same area, and carry their mains through the same streets by means of conduits, we are of opinion that it would not be advisable for the competitors to use the same conduits conjointly, as is suggested in the report, for reasons which will be evident to the contractors. The clauses relating to overhead wires are very satisfactory, but will probably be viewed with mixed feelings by Mr. Ferranti *et hoc genus omne*; however, he has two years before him to perfect his insulating material (at 4d. per lb.) which will withstand a tension of 10,000 volts.

The E.P.S. Company will doubtless feel keen disappointment at the result of its endeavours to place itself on an equality, as regards supply, with the true generators of electricity. Major Marindin very rightly regards the company as a useful adjunct to a supply corporation, and it ought now to have a large and profitable field for manufacturing business.

In closing this brief notice we would again impress upon the trade the necessity of careful and cautious work, undertaken on legitimate commercial lines to which the spirit of gambling must be a total stranger.

SECONDARY BATTERIES.

UNDER the very broad title "The Construction and Maintenance of Secondary Batteries," Mr. J. Appleton recently read a paper before the Old Students' Association of the City and Guilds of London Institute. This subject has received the most exhaustive treatment in

our columns from time to time in a long series of articles from the pen of Mr. Reckenzaun. These articles contain a vast amount of practical information all based on long experience and close observation, and, since their publication, but few important improvements have been made. Mr. Appleton does not pretend to advance any new ideas, and he confined himself to facts, which were well worthy of the attention of his audience, for within the narrow compass of his paper they were put together in a very sensible way. There are several points, however, which we may put before our readers either to make notes of or to discuss. In his introduction Mr. Appleton gives the usually accepted chemical reactions as they are *supposed* to occur in a secondary battery composed of lead plates immersed in dilute sulphuric acid, and he wisely guards himself by saying "there are differences of opinion as to the exact chemical action." We have on previous occasions pointed out that there are certain unsolved problems which ought to be tackled by competent chemists, since all the existing formulæ on the reaction of storage batteries are more or less hypothetical. The problem is, no doubt, extremely difficult; we ought to know, not only what changes take place when a cell is fully charged or completely discharged, but also the successive variations in a cell at intermediate stages of formation, charge and discharge. An exact knowledge of the chemical reaction at every stage would go a long way towards clearing up certain mysterious phenomena in the behaviour of some secondary batteries.

Referring to the historical part of the subject, the author remarks that "it is rather doubtful whether Planté used a coating of oxide mechanically applied to the lead plate, but Faure was the first to patent the pasted type of plate." M. Planté himself assured a friend of ours in Paris that he did experiment with lead oxides applied mechanically, and he showed the fact in an old note book of his, bearing a date which anticipates Faure by several years, but he regarded his experiment as unsuccessful and not even worthy of publication. M. Faure has been more fortunate in this respect.

Speaking of the various electrolytes which can be used Mr. Appleton says, "undoubtedly sulphuric acid and water is the best for continual work, but for quickness of forming there are others which allow the oxidising action to penetrate more deeply into the surface of the lead. Sulphate of magnesia and sulphate of soda are very good, and with the former I have obtained excellent results. A very soft and porous peroxide is obtained with this electrolyte, but if the action is carried too far it disintegrates. A very good plan is to form for a time in sulphate of magnesia, and then change the electrolyte to sulphuric acid, which hardens the peroxide. The cathode does not fare so well with this electrolyte, as a thick film or scale forms (probably a silicate), which is a bad conductor, and increases the resistance of the cell."

"The Crompton-Howell battery gives very good results with rapid discharges. For example: T 25 type, containing 125 lbs. of lead, the external dimensions being 14 inches × 12 inches × 12 inches, can discharge at 100 ampères for four hours, and this can even be increased up to 500 ampères, provided the capacity is not drawn on for more than 100 ampère hours. This is very useful in certain cases, especially in central stations on the accumulator system, as practically the whole of the demand can be met for a short time from the batteries if anything happens to the engine or dynamo." Then he described the E.P.S., Drake and Gorham, and Reckenzaun cells, which are all well known.

Concerning the Commelin-Desmazures and other types, the author advanced nothing which we had not described long ago in a more complete form.

A discussion followed the reading of the paper, in which Messrs. Jones, Reckenzaun, Esson, Swan and Lee took part, but nothing of a novel nature was elicited.

ELECTRICITY PRODUCED BY WIND POWER.

THE employment of the wind for motive power purposes on land is a subject which has for many years past engaged the attention of the scientific world, but so far the results obtained from experiments made have not been very successful, and we seem at present to be as distant as ever from the attainment of any really practical issue in the matter. That windmills for grinding corn have been employed for generations is a well-known fact, but their use is gradually being discontinued owing partly to their inefficiency as compared with steam-driven mills, and partly to the variable nature of the wind which renders it impossible for a windmill to be kept constantly in operation. In Holland and Egypt there are many windmills employed to drive pumps for raising water, and in America they may be counted by thousands. In the latter country they are used for keeping up a supply of water in agricultural districts and in the reservoirs at railway stations. In our opinion these few instances represent, with one single exception, the only modes in which the wind has been employed on land for motive power purposes.

The exceptional case referred to is at present to be found in France in connection with the Nord Lighthouse at the extremity of the Cap de la Hève, which is about two miles distant from Havre. Electricity is employed as the lighthouse illuminant, and at the time of the putting up of the installation it was resolved to endeavour to utilise the motive power of the wind for driving dynamos. Accordingly, a windmill or "wind-motor" as it is termed, of the modified Halladay type, was erected, and it develops about 18 H.P. when the wind is blowing at the rate of 33 feet per second. The wind-motor, which is mounted upon a wooden framework fixed upon blocks of masonry, imparts motion, by means of a vertical shaft and conical gearing, to a horizontal shaft placed at a suitable distance from the ground. On the horizontal shaft are mounted two

pulleys which, by means of belting, drive two dynamos of different sizes which are connected to a series of accumulators. The speed of the wind-motor is automatically regulated by an apparatus which opens or closes the sails according to the velocity of the wind. The intensity of the current of the smaller dynamo is 8 ampères when the latter is running at 100 revolutions per minute, and 40 ampères when the speed is 260 revolutions; whilst the larger dynamo gives a current of from 40 to 100 ampères for a speed of from 250 to 650 revolutions. The mechanical efficiency is 4 H.P. for the small and from 4 H.P. to 6 H.P. for the large dynamo. The dynamos are run alternately, according to the quantity of energy stored in the accumulators.

It will be seen from the foregoing that this installation is certainly unique in character. It was put up some time ago as an experiment, and has answered the expectations of those concerned. That this should be the case is not surprising, when we consider the fact that the installation is on a *small scale*, but what would happen if a proportionate success could be obtained in central stations, say, of the size of that at the Grosvenor Gallery, or that in course of construction at Deptford? Would not the directors of our electric lighting companies rub their hands and dance for joy at this El Dorado—at being able to dispense with steam engines and boilers, which decrease in initial cost would enable them to supply light probably at the same price or even cheaper than gas? The gas companies would be at their wits' ends, their shares would go considerably below par, and our gas contemporaries would have to shut up their offices. What tremendous excitement there would be at the half-yearly meetings of our electric lighting companies, and how satisfied the shareholders would be to think that dividends were *at last* going to be paid. The electric lighting panic of 1882 would stand no comparison with what would take place under such circumstances. Shares would be at an exceedingly high premium, and the electric lighting millennium would commence!

Alas! It is to be regretted that such a fanciful dream cannot be realised, for the simple reason that there are three serious objections to the use of windmills for driving dynamos. In the first place there are the periods of calm, during which no movement of wind appears to take place; in the second place, the irregular velocity of the wind; and in the third place, the imperfect construction of the receivers or windmills. It is quite manifest that the first objection is insurmountable. The second has partly been overcome in the instance described above, by the employment of an automatic apparatus which opens or closes the sails according to the velocity of the wind; but how far such an arrangement could be used on a large scale we will not venture to predict. The last objection is, doubtless, one which might be surmounted; but the impossibility of overcoming the first objection, and the indefiniteness of the second, are sufficient proofs to show that the wind will never be utilised on an extensive scale for motive power purposes, and especially as regards electric lighting.

OUR attention has just been called to a 4 H.P. oil engine which Mr. H. S. T. Biscoe has lately purchased from Messrs. Priestman Brothers, Limited, for driving an electric installation at his residence, Holton, near Oxford, and which is doing excellent work. We understand that previously to purchasing this engine Mr. Biscoe had used both high and low pressure steam engines and also a hot air engine, but, owing to the large amount of attention required and the quantity of water consumed, these were not found to be satisfactory. Mr. Biscoe has 44 16-C.P. lamps and the engine is driving a dynamo and charging 25 Elwell-Parker type B accumulator cells, and we are informed that everything runs as steadily and regularly as clockwork, requiring the least possible attention. Before the cells were supplied the engine was used for running the light direct from the dynamo and the lamps burnt perfectly steadily, which speaks well for the regular working of the Priestman engine. Mr. Biscoe states that for every 16 C.P. lamp burnt five hours, the cost is less than 1d. per lamp, taking oil at 7¼d. per gallon. Some 12 months ago we noticed this engine in our columns and we then thought there was a large opening for a reliable motor of this kind for a variety of purposes, and we are glad to hear that the makers are busy with orders in hand for home and abroad. In places where a quantity of water is not obtainable for boiler purposes and little attention can be given, this engine should be extensively used. Besides many Priestman engines supplied for electric installations, the makers have supplied engines, or have orders in hand, for grinding, pumping, threshing, ice-making, driving sewing machines, &c.

AS an example of the extraordinary ignorance which prevails of what is ancient history in electrical matters, we may instance a patent (No. 485, 1889) which has recently been taken out—by a foreigner it is true—in which "an electric generator consisting of two electrodes, the one of carbon, the other of zinc, inserted in the earth," is the subject of the claim. We thought that there was not a living soul in the electrical world who had not heard of this arrangement when they were studying the elements of electricity in their "teens." An alteration in the Patent Law which would prevent money being wasted by taking out patents of this kind seems very advisable.

WE publish to-day a very interesting case of the cure of tumour by the application of galvano-puncture. Dr. Inglis Parsons, whose remarkable paper on the arrest of cancer growth was published in our issue for the 10th inst., deserves every encouragement at the hands of his fellow practitioners to persevere in the path he has planned for himself. The success which has hitherto attended his skill must be very pleasing to his professional brethren for he has tackled two of the worst maladies with which medical men have to deal. There are several other desperate ills to which flesh is heir which we firmly believe will one day succumb to electro-medical treatment; in the meantime we have every reason to be thankful to Dr. Parsons for what he has already accomplished. People will soon begin to learn that there is a rational mode of applying electrical treatment to those who suffer, and this will do much towards putting an end to the frauds which have hitherto been perpetrated on the unsuspecting and ignorant by quack medical electricians, who know no more about electricity than they do of the healing art.

THE irrepressible and "eminent" Mr. Harness is again to the fore. The *Standard* of the 20th was issued with an unusual extra double sheet three columns of which were devoted to the advertisement of the notorious electropathic belt which is to cure almost every ailment under the sun. Unable, apparently, to obtain indisputable testimonials from the English faculty Mr. Harness goes across to the continent for statements to bolster up his preposterous declarations. Like the old party who derived such great spiritual consolation from hearing "that blessed word Mesopotamia," the general public will no doubt be greatly struck with the depth of science displayed by the advertiser when he glibly talks about "milliampères" "volt-ohms" (*sic*), &c., and states that "a milliampère has a curative value that is assuredly not to be neglected." The "eminent" should next prepare, "according to a recipe which has been discovered at a vast expense," electropathic pills each containing one milliampère of current; a large sale of these might confidently be expected and suffering humanity be largely indebted to the inventor. Seriously, however, what is the British medical profession about that this matter is not promptly taken into consideration? There is plenty of evidence to go upon and if the profession takes the subject vigorously in hand ample support will be given by real electricians in the way of professional opinions and advice. It is neither more nor less than a crying shame that the present state of things should be allowed to continue.

THE elaborate descriptive tests which Mr. Harness gives to prove the electrical efficiency of his belts, may no doubt serve the purpose of convincing the ignorant public that the appliances are constructed on correct scientific principles, but a very slight examination of the wordy paragraphs will show how grossly ignorant the advertiser is of electrical science. To show the existence of a current he connects a set of zinc with a set of copper discs through the medium of a high resistance galvanometer, the plates being in contact with a moistened cloth, and a steady deflection is obtained, thus showing the existence of a steady current. He omits, however, to state that the discs as applied to his belts are permanently short-circuited by a short piece of copper wire, and that the electromotive force which the couples possess will by polarisation be reduced almost if not quite to zero. Even if the connections between the discs were resistances, it has yet to be proved that a current passing over the surface of the skin between two discs placed close together can produce any beneficial effect.

THE pamphlet just issued by the "Committee for the Supression of Electrical Quackery," is being favourably reviewed in a number of technical and general newspapers. We trust that the object for which it is being circulated will be attained, but even if it suffices only to enlighten the minds of a few simpletons, we shall think that the articles and correspondence upon the subject which originally appeared in the REVIEW were not penned in vain.

MR. SPRAGUE made a statement some time ago that he would soon be able to place a motor armature in a tank of salt and water for twenty-four hours, then take it out, and run it right off. While this feat was in contemplation only by Mr. Sprague, a Mr. Greene has tried the experiment with success. He first put the armature into a barrel of fresh water; after soaking there for twenty-four hours, he removed it to a saline solution and let it soak for another twenty-four hours. The armature was then run in its machine for two and a half hours at some 33 per cent. overload, and at the end of that time no damage had been done to it. In future, it is not improbable that motor armatures will be subjected to this treatment as a necessary and obligatory test, previous to being passed for tramcar work.

THERE is some difficulty in determining what should be the minimum insulation resistance of a circuit for electric illumination. In some installations an insulation resistance of 500 times the ordinary working resistance of the circuit has been satisfactory; while the highest that has been proposed amounts to 50,000 times the full working resistance. This latter figure has lately been exceeded in an installation at the Colonnade Hotel, Philadelphia; the wires used throughout the circuits were of equal high-grade insulation which consists of an inner covering of pure rubber, an outer and thicker protective, and an insulating covering of vulcanised rubber, with a layer of textile wrapping to protect the rubber from mechanical injury. The utmost care was expended on making all joints perfect. The tests for insulation were made at the switchboard, so as to include the leakage of the whole of the system, and great pains were taken to ensure a good earth. The electromotive force used was 106 volts, obtained from standard cells, and the resistances were taken by the substitution method. The resistance of the entire network of wires and dynamo measured 2,664,000 ohms, an extremely good result when it is considered that the installation is for the supply of 1,000 lights.

IN spite of the prognostications to the contrary, at New York, on the Washington centennial celebration nights, a good show of illumination was forthcoming for the occasion. The removal of the poles from the streets by the orders of Mayor Grant had brought down on the mayor's devoted head the maledictions of the whole electric lighting fraternity. The condemnation was of no avail, the poles were destroyed without delay or hindrance of any kind, and underground the wires must go. The authorities of Boston, on the contrary, just at the moment when the crusade against poles and overhead wires in New York was at its height, have granted powers for the construction of hundreds of miles of pole lines and wires for electric railway work. And yet the Boston people have always had the credit of appreciating any improvements to their city, and of not forgetting to look at the matter from an æsthetic point of view.

THE great advocate for underground wires, one who thinks he has practically demonstrated at Chicago that it is as easy to work lines successfully below the soil as above it, Mr. John P. Barrett, when some prominent electricians told him the time had not come yet for burying the wires, replied: "Results prove your fears groundless. You say electric light wires cannot be operated underground. Come to Chicago and I will convince you that they can. If you really want to be convinced, if you are honest in your search for information, I will give you all the assistance in my power." Mr. Barrett, who now occupies so high a position in the electrical world, furnishes an example of what can be achieved by indomitable perseverance and diligence in attaining success in one's undertakings. He commenced active

life at twelve years of age as a ship's boy, afterwards rising to the position of an able seaman. After fifteen years' service his career at sea was terminated by a severe accident, by which two of his mates lost their lives, and he himself was made a cripple for life. On returning home to Chicago he was appointed fire watchman. This was his first public service, and the fire departments of his own and other cities are indebted to him for developing the fire alarm telegraph system in general use. He became a skilful operator, studied hard, introduced new ideas, suggested many improvements, and became recognised as the office authority. On becoming chief of the electric branch of the city service the whole fire alarm service was remodelled. He it was who introduced the device called the "joker," by which the alarms are received at the engine houses, and which at the same time releases the horses and calls the firemen to their duty. Since those days he has devoted himself to the police patrol system, underground telegraphs, the bridge telephone system, and a scheme for lighting the river by electricity, and many other things, as well as establishing a factory for the production of electrical goods. The most important work that he has carried through has been the lighting of the city, the wires being all placed in conduits underground, and the old poles and the unsightly net-work of wires removed, to the manifest gain of the city.

THE unanimity with which the Board of Aldermen of Boston, U.S.A., passed an order granting permission to the West End Railway Company, in addition to the rights already possessed by it, to erect poles, construct and extend their overhead single trolley system for motive power, will not prevent the opponents of aerial wires from taking steps to test the legality of the order, and to proceed to litigation sooner than allow the streets to be further disfigured.

THE revised set of rules, issued by the New England Insurance Exchange and Boston Fire Underwriters' Union, stating their requirements for electric lighting installations, is very full, and enters into many small details. Among others we notice the following fluid for soldering purposes, viz., saturated solution of zinc, five parts; alcohol, five parts; glycerine, one part. In rule 71 will be found a rough and ready means of testing a lighting circuit. "The wiring in any building must test free from 'grounds' before the current is turned on. This test may be made with a magneto that will ring through a resistance of 10,000 ohms, where currents of less than 200 volts potential are employed."

Prof. BARRETT denies the report spread by the advocates of overhead wires, that the success of the underground system in Chicago is due to the fact that the so-called buried wires are in reality fixed in tunnels built above ground, the Professor says that these tunnels exist only in the imagination of the reporter.

EVEN electrical traction, which has not really yet obtained anything like a strong foothold in this country, is in danger of being misrepresented. We have received an invitation to inspect a system of electric traction, the outcome of the inventive genuis of William D. Sandwell, but what there is in it of an original nature we fail to see. The gearing will not answer practical requirements, the double armature motor appears to be identical with that of Jarman, so why an esteemed contemporary should have devoted pages last week to an illustrated description of a half-developed scheme, embodying abandoned ideas, is more than we can conceive. We would advise Mr. Sandwell to study what has already been devised in electric traction and not to liken accumulators placed under seats in tramcars to dangerous steam boilers, or to speak of the *insurmountable difficulty* of withdrawing them for recharging. Such arrant nonsense is not only undignified but it shows him in a ridiculous light, and is not at all calculated to impress even the untechnical reader with the advantages of his system over others.

AT length some definite action has been taken at Portsmouth with the view of introducing the electric light into the borough under something like favourable auspices. Local gentlemen of influence are not wanting to "take fortune at the flood." Mr. Richard W. Ford, the Clerk of the Peace, who is the prime local mover in the new scheme, is the secretary of the Portsmouth Waterworks Company, which has under his careful supervision developed into a colossal concern, paying dividends well calculated to make the mouths of shareholders in other companies water. Several of the principal traders are also backing up the movement, the success of which is regarded as of great importance in relation to the future prosperity of this rapidly increasing borough. At the present time several tradesmen have private electric lighting installations, and it is hoped that with the facilities which the House-to-House Electric Supply Association will be able to provide, a large proportion of the shopkeepers will relinquish the use of gas in their shops. On the whole, if this latest scheme is only energetically pushed, it ought to escape the hapless fate of its predecessors.

PROF. LODGE did not get it altogether his own way over the lightning rod discussion, and we are therefore sorry to see that a contemporary, in a leaderette, has thought fit to twit Mr. Preece no less than four times about the length of his speech. This gentleman being the instigator of the paper and discussion, and being also recognised as the most doughty opponent of Dr. Lodge's theories, was certainly entitled to speak until he had nothing further to say; and we cannot, therefore, see the logic of calling Mr. Preece to task for keeping the attention of his hearers for a longer time than did anyone else.

THE more we hear of the Mammoth Combination, to which we alluded in our last issue, the more are we convinced that the best thing which could possibly happen, would be the inability of the provincial financier to carry out his gigantic idea. If dividends cannot be paid by the majority of the parties to the combination separately, the chances of so doing will be still more remote when they have amalgamated. We would like to ask what record the Vulcan Engine Works can show to render it eligible to form one of the co-partnerships? If these firms, like some breweries which were made into big companies a short time ago, could show large profits and dividends for a number of years in succession, there might be something to say in favour of the movement, although even in this case no amalgamation was attempted; as it is, every well-wisher for the real advancement of the electrical trades will re-echo our words. We fear that company-mongering is again rampant.

PHOTOMETRIC MEASUREMENTS OF ARC LAMPS.

By W. WEDDING.

WE have, through the courtesy of the author, received a copy of this memoir as read before the Berlin *Society for the Promotion of Technical Industry* in April last. We give the following summary of the results arrived at :—

Dr. Wedding remarks that the luminous intensity of arc lamps is as yet not satisfactorily determined. All kinds of glow lamps have been tested at various potentials and at different angles of eradiation, and decisive results have been obtained which are generally marked on the lamps themselves. It has been said that the arc lights Unter den Linden give an illumination of 2,000 or even 5,000 candle-power. But what is the meaning of these figures? Do they express the intensity of the light with or without a globe at a certain angle or do they indicate the mean spacial intensity? On the other hand, it has been determined by direct measurement that these lamps have a mean spacial intensity of only 500 candle-power, and the public was amazed on contrasting such figures as 500 and 5,000.

To decide the question as far as the lamps Unter den Linden are concerned, the Universal Electricity Company consulted Prof. Slaby, the director of the electrotechnical laboratory of the Imperial Physical Institute, who commissioned the author to carry out the investigation.

As the distribution of light from arc lamps is very unequal in different directions, a single measurement is not sufficient. It is necessary, at least, to measure through a quadrant from the horizontal to the vertical plane, and where the lamps serve to illuminate a covered space, from the vertical past the horizontal to the vertical again in the opposite direction.

In order to carry out the measurements at different angles, all determinations hitherto have been effected with mirrors. Upon these the rays fall at different angles—measured each time—and reflected thence into the photometer. The coefficient of absorption of the mirror must, of course, be known. Investigations of this kind were made in 1882 at the Munich Electrical Exhibition, and since by Herr von Hefner Alteneck in the establishment of Siemens and Halske, who has ascertained the weakening of the light by glass shades of different kinds. Arc lights were again examined in 1885 at the Vienna Electrical Exhibition. Lastly, I must notice the measurements executed at the Franklin Institute in Philadelphia with especial reference to carbons prepared in different manners. All these determinations have been effected with the aid of mirrors. In the Munich report it is mentioned that special care was taken in centering the carbons, as the distribution of light is otherwise very unequal.

The author's researches involve nothing new in principle and refer only to a single arc lamp, such as those fixed Unter den Linden, *i.e.*, the well-known Siemens "differential lamp." This lamp was fitted up in his laboratory by one of the engineers of the General Company of Electricity, and, according to his statement, burnt normally with a current of 14—15 ampères and an E.M.F. of 48—52 volts. The company supplied also three glass globes of different thickness and a reflector.

The lamp was fed by a Schuckert compound machine actuated by a gas motor, which was very carefully regulated, since small irregularities greatly interfere with photometry and yield useless results. An additional resistance of about three ohms was introduced in the circuit of the lamp, and a second resistance of $\frac{1}{4}$ ohm, at which the potential was measured with a torsion galvanometer. The intensity of the current was deduced from the potential and the resistance.

The same galvanometer was applied to the lamp by means of a commutator, in order to determine the potential at the clamps, so that both current and potential could be observed at one and the same time. As soon as the current reached the exact strength of 14 ampères a signal was given by the assistant in charge of the galvanometer, and whilst he determined the potential at the clamps the position of the photometers was read off by the author and another assistant. The observations were made, therefore, always at 14 ampères; the accompanying potential varied between 48 and 52 volts, and was mostly 49 or 50 volts, and fluctuated during a series of observations for an entire quadrant not more than 1 per cent. The length of the arc was photographed, and amounted to 2—3 millimetres. The photographic image was taken at right angles to the direction in which the measurement was executed. All the measurements were effected without a mirror. The lamp was hung to the ceiling by means of a pulley, and could be drawn up to the height of 8 metres above the work-table, so that both the horizontal and the perpendicular rays, with all intermediate positions, could fall into the photometer.

The photometer used was that of Bunsen in the form designed by Elster.

As the height of the room enabled the author to dispense with mirrors, he was in a position to measure the strength and the distribution of the light in two diametrically opposite directions. By this means the difficulty arising from the carbons burning unequally on opposite sides was obviated. The author had merely to measure through the quadrant on the left and the right and to deduce the mean intensity from the corresponding values on each side.

The unit taken as the basis of the measurements is the German normal candle, with a flame height of 45 millimetres. In the explanation given along with these candles the height of the flame is specified as 50 millimetres, but at this height it burns unsteadily, whilst at 45 millimetres it burns much more steadily and gives off exactly as much light as the English normal candle (spermaceti), with a flame 45 millimetres in height.

As the arc light cannot be directly compared with the candle, which is too feeble, an intermediate standard of comparison is needed—a matter much less simple than it seems at first sight. The light of the arc lamp appears white to our eyes, whilst that of the candle, the glow lamp, or the gas flame is yellow or red. Therefore, in photometry we have the unpleasant difficulty that the oil spots do not disappear, but appear red on the one side and blue on the other. Hence we are compelled to judge when the outlines of the spots appear equally indistinct. This seems impossible to the inexperienced observer, but after having made a few hundred readings the eye becomes so habituated that the colours are disregarded. In order, however, to minimise the difficulty, flames for comparison are sought which appear white to the eye, but which are not necessarily the largest lamps.

Since glow lamps could not be used for comparison, gas was adopted. Two so-called "Albert* burners" were selected on account of their great constancy, their compact form, and the fine clear light of 25—30 candle-power. To each was attached a gas meter and a pressure regulator. Nevertheless, small fluctuations cannot be avoided with gas burners.

For the measurement the most favourable time was selected, *i.e.*, in winter from 5 to 8 p.m., and in bright weather from 9 a.m. to 3 p.m. To compensate fluctuations as far as possible, all the gas burners were lighted in the workrooms adjacent to the photometric room. The procedure in a measurement was as follows :—

We have a horizontal plane in which the two comparison flames are at points which we will call A and B, whilst between which are the two photometers, P and P'. Perpendicularly over the middle point between A and B hangs the arc lamp, L, at a variable height, *c*. Right between A and B is a black cloth used for screening off either light as it may be required. In the first place, the two gas burners were adjusted to exactly the same degree of brightness, *i.e.*, a photometer was placed exactly in the middle between A and B, and one of the flames was regulated until exactly equal in luminosity to the other. One flame was then screened

* This may be intended for Argand.—EDS. ELEC. REV.

off, and the other was measured very accurately in comparison with a German normal candle.

The arc lamp was then kindled, and the photometric operation was begun in about 20—30 minutes. The two photometers were displaced, and the inclination of the paper screens in each photometer was regulated to an equal incidence until the illumination of the oil spots was equal. If it was found after commutation that the current had remained at the same strength (14 ampères) a second reading was taken by the three observers. A third value was rarely obtained. It was then necessary to wait for about two minutes until the lamp was regulated again. On the average, four observations were made for every angle. It was found essential to measure both quadrants through in 12—14 different angles in the shortest possible time, which was effected in 1½ hour.

The details of the author's results are given in a series of 11 tables, with the aid of 23 diagrams. It appears that each lamp suspended in Unter den Linden, when fitted with globe and reflector, gives out an illuminating power. not of 5,000 or 2,000, but only of 510 normal candles, which approaches fairly to Herr Elster's determination of 500 normal candles.

CALCULATION OF THE SIZE OF ELECTRIC LIGHT CONDUCTORS.

IN calculating the size of electric light conductors two points have to be considered, first, what the sectional area must be in order that the conductor may carry the required maximum current, *i.e.*, in order that the current density may not exceed the required maximum; second, what the sectional area must be in order that the loss of potential over a given length may not exceed a certain amount. These two conditions can only be exactly satisfied in a particular case, and, therefore, under other conditions it is necessary to calculate by one or other of two formulæ, the particular formula used being the one which brings the conditions required within the rule expressed by the other formula.

The resistance, r, of a wire whose length is l, and sectional area, a, is

$$r = \frac{l}{a} \text{ K}$$

where K is a constant.

Now the resistance of a pure annealed copper wire one foot long, whose diameter is ·001 inch is, according to the B.A. report on electrical standards, p. 227, 9·718 ohms at 0° C. The resistance of a similar wire at 60° F. (the usual mean temperature), *i.e.*, at 15·5° C., may be calculated from Table XI. on page 228 of the same report. Thus we have in this table—a wire 1 foot long weighing 1 grain has at 15° C. a resistance of ·2186 ohm, and at 16° C. a resistance of ·2194 ohm, the approximate resistance, therefore, at 15·5° C. (60°F.) will be

$$\frac{\cdot2186 + \cdot2194}{2} = \cdot2190,$$

and as the resistance of a similar wire at 0° C. is ·2064, the resistance of a wire 1 foot long whose diameter is ·001 inch will at 60° F. be

$$9\cdot718 \times \frac{2{,}190}{2{,}064}.$$

From this the resistance of a wire 1 yard long, and having a sectional area of 1 square inch, equals

$$9\cdot718 \times \frac{2{,}190}{2{,}064} \times 3 \times \cdot001 \times \cdot001 \times \cdot7854$$

$$= \cdot000024295 = \frac{1}{41{,}161} = \frac{1}{40{,}000}$$

approximately. Hence we get

$$r = \frac{l}{a} \div 40{,}000$$

where l is in yards and a in square inches.

Now, if p be the percentage of fall of potential along the conductor, and E the electromotive force of the dynamo, then if e be the difference of potential between the ends of the conductor (including the return circuit), the current flowing will be

$$\text{C} = \frac{e}{r},$$

and

$$e = \frac{p}{100} \text{E},$$

therefore

$$\text{C} = \frac{p\,\text{E}}{100\,r} = \frac{p\,\text{E}\,a \times 40{,}000}{100 \times l} = \frac{p\,\text{E}\,a}{l} \times 400,$$

therefore

$$a = \frac{c}{p\,\text{E} \times 400} \times l.$$

But the rule that the sectional area of the wire must be in proportion to the ampères to be carried is

$$a = \frac{c}{\text{A}} \qquad (1)$$

where A is the maximum number of ampères per square inch, the wire can safely carry;

therefore

$$\frac{c}{\text{A}} = \frac{c\,l}{p\,\text{E} \times 400}$$

or

$$l = \frac{p\,\text{E}}{\text{A}} \times 400.$$

This formula gives the length of conductor which with a current, C, and an electromotive force, E, will make the percentage of fall of potential exactly p, and will at the same time make the current density exactly that corresponding to the formula $a = \frac{c}{\text{A}}$.

If now we make l longer than this value and we increase the area in the some proportion so that p remains unaltered, then the density of the current becomes, of course, diminished, hence the rule expressed by formula (1) is not exceeded.

On the other hand, if we make l less than the value named and we decrease a in proportion so that the percentage, p, remains unaltered, then the density of the current becomes increased and the rule expressed by formula (1) becomes exceeded. Hence we get the following rule:—

If the length of the circuit *exceeds*

$$\frac{p\,\text{E} \times 400}{\text{A}}$$

then the value of a must be calculated by the formula

$$a = \frac{c}{p\,\text{E} \times 400} \times l;$$

if the length of the circuit is *less than*

$$\frac{p\,\text{E} \times 400}{\text{A}}$$

then the value of a must be calculated from the formula

$$a = \frac{c}{\text{A}}$$

An example will render this clearer. Suppose the electromotive force of the dynamo to be used is 110 volts, the percentage of loss not to exceed 5 per cent., and the current per square inch of section of the conductor not to exceed 1,000 ampères; then

$$l = \frac{5 \times 110 \times 400}{1{,}000} = 220 \text{ yards},$$

hence if the leads required *exceed* 220 yards in length, their sectional area must be calculated by the formula

$$a = \frac{c}{5 \times 110 \times 400} \times l = \frac{c}{220{,}000} \times l$$

where c is the maximum current the leads are required to carry.

But if the leads required are *less* than 220 yards in length, then their sectional area must be calculated by the formula

$$a = \frac{c}{1{,}000}.$$

Of course, if the leads are exactly 220 yards in length then either formula may be used, and both will give the same result.

H. R. KEMPE.

RAILWAY ACCIDENTS OF 1888.

ON the face of the Returns recently issued by the Board of Trade it would appear that the casualties resulting from the railway traffic of the kingdom for the year 1888 present a more favourable aspect than those of the preceding year. Such is not, however, the fact, for had it not been for the sad results of the Hexthorpe accident, the year 1887 would have stood out conspicuously as the year during which no passenger's life would have been lost from what is termed railway accidents. The Returns for the past year show a total loss of life of 905, as against 919 for 1887, and 3,826 injured, as against 3,590 injured for 1887. This includes accidents to servants, trespassers, &c. The sum total is a heavy one, and no one can scan such a result without feeling a desire that the time may come when our railways will be able to show a cleaner bill than is yet the case. In considering this question it is but just we should not lose sight of the fact that here we have brought before us, by the reports and returns of a Government department, every casualty which occurs; nor should we forget that those companies by whom this casualty list is made up are concerned in carrying on a vast business. Nor is it less than justice also to bear in mind that every casualty forms matter of enquiry on the part of, not only the company concerned, but, in a large number of cases, the Board of Trade, purely with the desire of arriving at such means as will prove most useful in preventing a recurrence of the circumstance. With such machinery in operation it may fairly be argued that what can be done to obviate accidents is being done, and that although casualties are more or less insuperable from the amount of traffic which the business of the country demands of the railway interest. yet the majority of our railways have of late years done much to establish upon their lines protective appliances for the preservation of life and the safety of the traffic. It is to the extension of these appliances that we look for further amelioration in respect of railway accidents. The sources of accidents are so numerous, frequently so unthought of, that the introduction of any one improvement can hardly be expected to wipe out all chance of accident, but every improvement will form its quota and help to reduce the lump. No factor in the protection of railway traffic has played a higher part than the block system; and, in recent years, it is probable no greater safeguard has been introduced than the automatic break. The same may be said of the interlocking system of signals—indeed, it may well be urged that without these the railway traffic of our great lines could not now be worked. And yet it is clear to every careful and considerate thinker that the security thus obtained may be largely improved. The block and the interlocking systems, as they are understood, are the offsprings of different periods, and have been, and still are, treated as independent, and are worked independently, or, rather, the governing link which ties them together is that of command and not of compulsion. The electrical signal may say to the signalman, the "line is blocked," and you must not allow any train to come forward; but that does not absolutely prevent him from taking off his outdoor signal to allow a train to proceed. What is required to render the block and interlocking systems perfect is the complete interlocking of the one with the other, so that when the signalman who has the command of the section for an approaching train sees that the road is not clear, he may not only intimate by the electric signals to the signalman in the rear that such is the case, but he must by the mere setting of his electrical signals at that signal-box lock the outdoor signals so that they cannot be taken off.

The adoption of such a system must add largely to the safety of the traffic. If block systems are necessary at all, then it is most desirable they should be made as secure and as comprehensive as is possible. The electrical and the mechanical should be so combined that the action of the former should govern the action of the latter. The principle has more than once been advocated in these pages, and not unfrequently recommended by the Board of Trade, and we feel that dealt with by degrees by the railway companies the difficulty of accomplishing so desirable an object would not prove a very troublesome or a very expensive matter. It would certainly be material in saving some of the collisions which now annually occur. During the past year there were reported 35 collisions between passenger trains or parts of passenger trains, and 54 collisions between passenger trains and goods or mineral trains, resulting in the death of 4 servants and injury to 464 passengers, together with injury to 45 servants of the companies. We do not presume to think if that which we urge were carried out it would prevent all this loss of, or injury to life, but we do think it would alleviate it to some extent.

In opening this article we quoted the total number of killed and injured during the year. These figures, as stated, cover every cause of casualty. The accidents to trains, rolling stock, permanent way, &c., caused the death of 11 passengers and 7 servants, and injury to 594 passengers and 93 servants. For the year 1887 the figures stood:—Passengers, killed 25; injured 538; servants of companies, killed 8; injured 109. The remainder of the sum total is made up by accidents to servants of companies or contractors; persons passing over railways at level crossings; trespassers (including suicides), &c. Our purpose, however, is not so much a general analysis of the causes of accidents resulting in this loss of or injury to life, as a consideration of those causes, the results of which may, by a judicious application of electrical science, be reduced to less serious dimensions. Electricity can be of little service in preventing trains from leaving the metals, but it ought to be available for preventing, by being employed to afford timely warning to gatekeepers of the approach of trains, some of the 57 cases reported, and which caused injury to two servants of the companies. We feel sure that if railway managers would call to their aid the ingenuity and services of their telegraph engineers they would find in them a means of meeting some of the responsibilities which attach to the undertakings so satisfactorily in the majority of instances piloted by them.

ON THE GROWTH OF CITY TRAFFIC IN NEW YORK AND LONDON.

By A. RECKENZAUN.

IN the City of New York the demand for transit facilities has doubled during the last 10 years; the great bulk of the long distance traffic is concentrated principally upon the elevated railways, which carried over 116,000,000 passengers last year, an increase of nearly 2,000,000 upon the traffic of the previous year. When first constructed the speed between the stations was maintained at the rate of 20 miles per hour, but owing to the enormous growth of traffic and the corresponding increase in the number of trains, which run every two minutes during the busiest hours, the average speed, including stoppages, is now hardly more than 10. Thus the limit has practically been reached, and everybody grumbles at the comparative slowness of the trains. The rolling stock of the New York elevated railroad

consists of 266 steam locomotives and 800 passenger cars, and there are 32½ miles of double track, and a total of 84 miles of single track line. The elevated structures were designed to carry locomotives of not more than 22 tons weight each, but already the demand is greater than these engines can supply. The cars weigh 11 tons each, and have seats for 49 passengers; but it is a common occurrence to see 100 and even 120 persons crowded into each car during the busiest hours. A train consists of five cars, which often makes, when overloaded, 100 tons, and this is as much as the present locomotives can draw with full steam on.

Both the railway company and the Daft Electric Company have long recognised the imperative necessity of improvements, and consequently a series of very successful experiments have been carried on with the Daft electric locomotive. But the ideal method would be to provide each car, or better still, each axle with its own motor; by this means the weight would be properly distributed, and the average speed could be increased by 50 per cent., because the starting and stopping through the instrumentality of a number of small electric motors, actuating a corresponding number of driving wheels, could be done more quickly and more effectively.

All the busy streets of every city in the United States are supplied with tramways. Omnibuses are almost unknown, and cabs scarce. In New York city there are 246 miles of tramways, on which run 2,100 cars, drawn by 14,000 horses, and 210,000,000 passengers were carried last year. This city is about 15 miles in length, and its average width is barely two miles, consequently private residences have been forced out of the business centre "down town" to considerable distances "up town," and to the neighbouring cities across the rivers.

Of electric railways or tramways with overhead conductors there are at least 50 working successfully in various parts of the States, but New York will not have any more posts and wires in its streets; therefore the only means of increasing the transit facilities is by underground railways, which have repeatedly been suggested, or by electric surface tramways, with electric motors supplied with energy from underground conductors or storage batteries.

At the summer convention of the National Electric Light Association, held at Boston, Mass., in 1887, I read a paper on "Storage Batteries for Electric Locomotion," and strongly advocated this means of transit for crowded thoroughfares. Again, in September of the same year, I read a paper before the American Institute of Electrical Engineers, New York, at the instigation of their excellent president, Mr. T. C. Martin. Both papers were followed by a long discussion, and during that upon the latter, I pointed out the great advantages of electric cars in such crowded streets as the Broadway, New York, where every square inch of space is of value. I stated that, if we did away with horses, we should save in length about 12 feet, and in width the distance between the rails for each car on the road. There are hundreds of cars on this line following in succession, sometimes less than 50 yards apart, and doing away with horses would save thousands of square feet of space where other vehicles could pass. Another great advantage with electrical propulsion would be (apart from the certain economy in traction expenses), that passengers can travel at a greater speed. Horses cannot pull a car at a greater rate than six miles an hour, and the average speed of horse-cars in America and Europe is barely five miles an hour including stoppages. Two electric cars running at an average rate of 7·5 miles would thus convey as many passengers as three horse-cars of the same size. Moreover, horse-cars cannot be increased in size without providing an extra team, which is quite impracticable; whereas by lengthening an electric car a few feet the accommodation can be very considerably increased. In Philadelphia we had an electric car running with accumulators, which was 6 feet longer than an ordinary horse-car, and in which 100 to 125 passengers were often carried. Such cars will be adopted on several lines, since the success of this has been amply proved. In Sacramento ordinary sized cars, driven by accumulators, continue to be used.

The Julien Electric Company has made a good impression with its storage battery cars on the Fourth Avenue, New York, and according to published accounts the earnings of the electric cars were 50 per cent. higher than the earnings of the horse-cars on the same line, whilst the working expenses are claimed to have been less. It has therefore been amply proved that electricity supplies a ready and economical means of greatly increasing the transit facilities in crowded thoroughfares.

London is differently situated. It has a much larger area than New York spread in every direction. Its streets are crooked and narrow, but the pavements are excellent. It has no elevated railroad, at least not in the American sense, although most of our suburban railways run above, or upon a level with, the house tops. Omnibuses are here an imperative necessity and a great convenience.

The figures given in a paper "On the Street and Railway Traffic in the Metropolis," read before the Society of Arts on the 15th inst. by Mr. J. Stephen Jeans, enable us to appreciate the extent of the Metropolis. We shall only confine ourselves to those relating to passenger traffic, and refer readers interested in other statistics to the Journal of the Society.

The possibilities of London, says Mr. Jeans, are difficult to measure. Given a present population of 4,500,000, an increase of upwards of 500,000 every ten years, and the extent and requirements of London a century hence would not be easy to imagine, far less to estimate, for we should then have a population of 10,000,000 souls.

The passenger traffic of London is mainly in the hands of the railway companies, the six principal lines serving the metropolis in this regard, carrying annually over 200,000,000 people. The tramway companies carry unitedly some 150,000,000 more, and the London General Omnibus Company, and the London Road Car Company, who divide between them the lion's share of the 'bus business, carry from 120 to 130 millions per annum additional. Besides the provision made for passenger transport by railway, omnibus, and river steamers, there are in London some 11,300 cabs, which carry annually about 30,000,000 passengers. The really practical part of the problem which Mr. Jeans had undertaken to consider was: How shall we economise space, and minimise the now serious and steadily increasing dangers of the public streets for those who are compelled daily to travel to and fro in this great metropolis? The increase in street traffic, measure it by whatsoever standard we will, is amazing. Take the case of the General Omnibus Company alone. Between 1880 and 1887, the company increased the number of passengers carried from 56,000,000 to about 100,000,000, and the number of miles run from 13,000,000 to 18,000,000 per annum. On the Metropolitan (Underground) District Railway, the total number of passengers carried in 1872 was 20,098,000, which had increased in 1887 to 36,578,000, or about 80 per cent. in 16 years.

The following statement shows approximately the number of passengers transported in London in 1887, and the sums for which they were carried:—

	No. of passengers.	Receipts.
Metropolitan Railway ...	67,305,000 ...	£581,319
Metropolitan District Railway	36,578,000 ...	385,199
North London Railway ...	29,147,000 ...	301,507
Tramway Companies	145,902,000 ...	854,130
General Omnibus Company ...	93,000,000 ...	634,000
Cabs, &c.	30,000,000 ...	2,250,000
Totals	401,932,000	£5,006,155

In addition to these figures, very large numbers of passengers are carried daily to and from the suburbs by every railway that has a terminal station in the metropolis. Probably the numbers so carried will, in the aggregate, nearly double the numbers shown above to be carried by railway, and bringing up the total

numbers carried annually into and out of London to between 490,000,000 to 500,000,000.

The conditions, says Mr. Jeans, under which the passenger traffic of the metropolis is now carried on is likely to be greatly modified before long, in consequence of the extended use of electricity as a motive power. Lord Bury's company have undertaken to make experiments with electricity on the Metropolitan line ;* and Messrs. Mather and Platt have undertaken the construction of a complete electric railway for working the traffic in the City of London and Southwark subway, where it is proposed to run 2,200 trains per day.

Electric railways and tramways have now passed beyond the region of mere experiment. They have been worked successfully for years in many places, and even an omnibus has been found to answer without any auxiliary horse-power. It would be absurd to suppose that we shall "rest and be thankful" at the present stage of the electric power question. There are, no doubt, difficulties to be still overcome ; but the feasibility of the use of electricity for propulsion of almost any description has been proved, and that is three parts of the difficulty overcome. Besides, the electric world is now in real earnest.

Three important projects are at the present time either in course of execution or contemplation for the purpose of relieving the congested traffic of the streets of the metropolis. They are :—

1. The Metropolitan Outer Circle Railway.
2. The City and Southwark Subway.
3. The proposed railway from Piccadilly to Holborn Circus.

The object of the first undertaking is, by an independent line, in the hands of an independent company, to connect all the different railways that surround London, not only *inter se*, but also with the system of docks at the east, and especially Tilbury.

The second undertaking, which is likely to be opened in August or September next, will afford a means of communication between the City, by a station near the Monument, with the South side, the other terminus being in the neighbourhood of Stockwell.

The third project, for which Parliamentary sanction is now being sought, has for its object to establish a line of communication between Piccadilly and Holborn by two small tunnels for railway trains to be worked by electricity, and two parallel galleries for pipes and sewers.

Another project has been talked about, the object of which is to have a railway constructed between Westminster and Edgware Road, but it has not been regarded with much favour.

Mr. Jeans has taken an immense amount of trouble by compiling statistics on the traffic in the City of London, and showing the difficulties experienced at times in coping with the increasing demands, and he suggests that the whole subject is one that it would be well worth while of the Society of Arts to consider in conference, and it would not be amiss to offer prizes for suggestions as to the best means of mitigating the evils that now beset our street traffic—whether by new systems of transport, by additional lines of railway or tramway, or by other means which must be well within the limits of the practicable.

The author, in reply to various speakers, said that he was a little disappointed that no part had been taken in the discussion by any of the railway managers or representatives of railway companies, though he had no doubt the paper would come to their notice, and in that way the suggestions made would be considered.

The above statistics are well worthy of the study of every electrical engineer. The public will soon learn to recognise the possibilities of electric traction, and then call loudly for a solution of this important problem ; the more minds there are engaged upon its study the sooner we shall be ready for the supply of a growing demand. Whether elevated or underground, the future metropolitan railways will be worked electrically. Let us hope that the Society of Arts will act upon Mr. Jeans's suggestion of calling a conference and offering prizes for the best schemes. There will be no lack of practical ideas.

* This we believe, and hope, has been abandoned as far as the original idea was concerned, viz., propelling passenger trains with storage battery locomotives.—EDS. ELEC. REV.

A CASE OF PELVIC TUMOUR TREATED BY GALVANO-PUNCTURE: CURED.*

By J. INGLIS PARSONS, M.D., Assistant Physician to Chelsea Hospital for Women.

No one who has had practical experience of galvano-puncture will have the hardihood to deny its power of destroying almost any tissue with which it comes in contact. It also accomplishes this in a way that no other agent is capable of doing ; and, when surgical procedure is quite inadmissible, it is a direct means of saving life, as the notes of the following case show :—

Mrs. W., aged 44, married ; family none ; one miscarriage eighteen years ago. Menstruation always been regular, loss slight, until October 13th, 1887, when she had a severe attack of hæmorrhage, lasting several days.

October 28th.—Admitted into Chelsea Hospital for Women, under Dr. Edis.

November 1st.—Examination : A mass as large as a fœtal head can be felt between the bladder and uterus, projecting above the pubes, and pressing down the anterior vaginal wall. The cervix can be felt high up and far back ; the anterior lip is enlarged. Sound passes upwards backwards, and shows uterus to be separate from the tumour.

November 7th.—The patient complains of great pelvic pain, with occasional vomiting, and pain on micturition. Ether was administered, and a consultation held. It was agreed that the tumour was either a fibroid or sarcoma ; and that, from its position and close attachment to the bladder and surrounding organs, no surgical procedure was admissible beyond puncture with a fine trocar. Somewhat serious bleeding followed this procedure, and was checked in the usual way.

November 25th.—As the tumour rapidly increased, Dr. Edis passed the case on to me for galvano-puncture. The first application was on November 25th, 1887, and the last on February 6th, 1888. In all, 28 were made between and inclusive of these dates. The duration of the applications varied from 20 minutes to half-an-hour ; intensity of current from 100 to 250 milliampères, average 150. Two fine insulated platinum needles were used. These were driven through the anterior vaginal wall into the tumour to a depth of 1 inch, and connected to the positive pole. A large copper electrode on a felt pad, placed over the abdomen, formed the negative pole. No anæsthetic was used, nor was it required, as the introduction of the needles caused no pain. The temperature rose only once, on December 13th, 1887, to 102° F., but in a few days it was normal again. A depression could be felt in 48 hours after each application of the current, corresponding to the site of puncture, and large enough to admit the index finger. After each application, the vagina was well douched with a carbolic injection (1 in 60) ; an iodoform pessary was passed morning and evening. At the end of the treatment, it was impossible to introduce a needle without causing pain, showing that very little of the tumour was left. Bimanually nothing could be detected by the hand on the abdomen ; *per vaginam* a hard board-like mass could be felt, spread out between the uterus and bladder, and in front of the anterior vaginal wall. She has no pain now ; no vomiting. Two-thirds of the tumour have disappeared.

April 6th, 1888.—The patient came up to town ; has been in excellent health. On examination, the local condition remains unaltered.

* *British Medical Journal.*

October, 1888.—One year after the commencement of her illness, she was in very good health ; no sign of recurrence. The tumour is still one-third of its original size.

Remarks.—Hitherto, considerable diffidence has been felt in resorting to this method, on account of the difficulty experienced in insulating the needles with any material capable of adhering to them when they are driven into the tissues, and of standing the action of acids and alkalies which form at the respective poles. For if puncture be made through the vaginal wall by a non-insulated needle, the current acts on the vagina as well as on the tumour, and a sinus communicating with the tumour is the result. Whereas, if the needle be insulated so that only the point be left exposed, the current acts on the tumour alone and the vaginal wall remains intact, except for the small opening made by the passage of the needle, and which soon closes up. By this means the chances of septic infection are reduced to zero.

Galvano-puncture has often been compared by those ignorant of its use to the actual cautery. The difference, however, is very wide. With the latter, whatever tissue comes in contact with it is charred by the heat, and destroyed, and it is utterly impossible to apply it to a tumour covered by healthy tissues, such as the vaginal wall, without first destroying them, and so producing a sinus with all its attendant risks. Whereas, with galvano-puncture by insulated needles, there is no damage done to the healthy tissues, which have to be pierced first in order to reach the tumour ; the insulation protects them from the current, while the bare point acts on the tumour. Nor is there any development of heat sufficient to produce an appreciable effect. The reason is this : Nearly two-thirds of the electrical force are expended in electrolysis. As the current enters the body it spreads out, and finally converges on the other pole. Any development of heat, caused by the resistance of the needles and the body, is spread over a large area, and is quite insignificant. Ciniselli has given up trying to insulate needles. Apostoli, Onimus, and Legros use a movable sheath. But if this is driven into the tissues and makes too large an opening, it is apt to set up a sinus. If it is not so used, the current will come off at the point of entry and produce the same result.

The insulating material used is gutta-percha, put on in fine layers, compressed and tapered down towards the point, so as to have no shoulder. The inert mass left behind in this case is, no doubt, the fibrous tissue of the tumour, all the rest being destroyed.

REMARKS ON FRANZ WILKING'S "CONTRIBUTIONS TO THE HISTORY OF TRANSFORMERS."

By A. GELYI.

(*Concluded from page* 557.)

In his essay Rankin Kennedy explains that if several secondary generators are inserted in series and the secondary circuit in one of them is altered, the main current thereby undergoes a change which must be felt in the rest of the secondary generators.

Hence he draws the conclusion that the distribution of electric light by means of secondary generators is practically useless. He condemns the system (not merely the system of generators inserted in series, but altogether the system of distributing electric light by means of secondary generators), and he concludes with the proposition that parallel introduction might be a fine system of self-regulation were it not for the enormous leads.

In this concluding sentence many persons, including Herr Wilking, have endeavoured to read matter which it manifestly does not contain.

In the same issue of the ELECTRICAL REVIEW (XII., No. 289, p. 486) follows an editorial article which, in connection with Kennedy's memoir, denies to induction apparatus the value recently claimed for them by Gaulard and Gibbs, and from the same reason that without regulation the system is useless, and that a regulation proposed by Gaulard by means of movable iron cores does not effect any improvement.

The same leading article, after confirming the non-existence of a practical system of distribution, adds that "the experiments of Mr. Kennedy will doubtless have the effect of inducing others to follow up the subject."

To the expert author of the leading article, after studying Kennedy's memoir, the problem still seems as far from its solution as it was previously. He sees that Kennedy's experiments confirm the imperfection of the system of secondary generators, and in Kennedy's concluding sentence he finds no answer to the question, but merely an exhortation to pursue the subject further, in the hope of perhaps arriving at the goal which was hitherto unattained.

If Kennedy's words involved the meaning which has since been *fabled* into them, the leading article would certainly have said that the endeavours of Gaulard, Jablochkoff, Bright, &c., have been misdirected, but that Kennedy has shown us what to do or that : "the distribution of a current with secondary generators is a solved question." But instead, the article merely points out the failure of secondary generators. The author, therefore, as little as any other reader, had learnt from Kennedy's memoir how a current may be distributed and regulated by means of secondary generators.

Kennedy himself and the many other experts who were at that time engaged in a close study of the transformer system, would not have omitted to rectify the assertions of the above-mentioned leading article if they were found to require any correction.

Such an omission, especially on the part of Kennedy, is the more striking as he, shortly after the appearance of the leader just mentioned, returned to the same subject in the very same paper.

The American patent of Edison (No. 278,418, May 29th, 1883) cited by Herr Wilking as last, but not least, is in nowise identical with the invention which he combats, for Edison's specification mentions merely a single feature (the parallel insertion) of that combination which forms the subject of the German patent in question. And even this one feature refers to a distinctly different object, that is, to the transformation of continuous currents which are periodically turned by means of revolving commutators. With touching simplicity Wilking declares that "remarkably" (?) in this otherwise very complete description *the maintenance of an equal tension is not mentioned with a single syllable.*

He certainly sees fit by this opportunity to overlook that the unvarying tension in the present case is not such a matter of course as he would wish it to appear ; on the contrary, the maintenance of an equal tension in the primary leads would not have had the same effect in Edison's system as that treated of in the Déri patent. Constancy of the primary tension would not have occasioned a constant tension in the secondary net, because the considerable losses in Edison's apparatus must of necessity destroy the proportion between the primary and the secondary tension.

It has further never occurred to Edison to attempt anywhere the industrial utilisation of the system which he patented in America. It has not in any case met with a practical application.

Herr Wilking, consequently, has not succeeded in disentombing a single anticipation which would cover the essence of the German patent, No. 33,951, *i.e.*, which treats of a system of current distribution characterised, like Déri's, by :

a. The grouping of the induction coils for alternating currents in secondary distribution stations, thus forming local circuits, and enabling the union of all the induced coils of a secondary station to one common local circuit.

b. By combining the single groups of induction coils and of the several stations of the second rank with the

main leads of the primary current by means of a ramification of the latter.

c. Thereby, that the tension of primary current at its entrance into the secondary stations is as far as possible kept constant.

The combination of these features favours the essence of the system of distribution described in Déri's patent, which fully answers to its name, since it enables us to transmit electricity from a centre of production by means of cheap leads, not only to great distances, but also to distribute it to an unlimited number of consumers over wide spaces, and to place it at their independent disposal for any purpose whatever.

This system of distribution was unknown before the promulgation of Déri's specification. On the contrary, as I have incontestably shown, until such publication the want of such a system was universally felt, and was repeatedly emphasised by experts in public lectures and journals without Kennedy, Marcel Deprez, or any one else being able to point to any existing solution of the problem, and without a single electrician having applied or recommended those means which characterise the above-mentioned system of distribution with alternating current transformers.

How, under such circumstances, this system can be pronounced to be something already known, and consequently wanting in the attributes of patentable invention, is really inexplicable, or can be explained only by the motives which impel the persons concerned to such assertions. Against a style of criticism such as Herr Wilking adopts, not even the most novel and original invention can be maintained. If those elements by the combination of which an invention arises (single elements, indeed, cannot be invented, but may, at the utmost, be discovered), are torn out of connection and tested as to their novelty, the dictum of Solomon becomes applicable, that there is nothing new under the sun.

Such a style of criticism is very aptly ridiculed by the following passage in a leading article of the *Electrical Engineer* (April 26th, 1889) :—"Iron, coal, and water existed in the time of Solomon, but the combination resulting in the steam engine did not."

As to the second part of Wilking's polemics—to call his "Contributions" by their true name—I can briefly remark that amongst the apparatus which Wilking describes as "transformers without magnetic poles," some of them *are not transformers* at all, whilst among those which are really transformers, besides those of Zipernowski-Déri-Blathy, one alone, that of Hopkinson, is non-polar.

The apparatus of Kennedy (fig. 6, English patent, 1882, No. 4,752) is not a transformer, but an alternating current machine, and, as Kennedy expressly shows in his specification, either a machine excited from without or a magneto-electric machine, since permanent steel magnets may be substituted for the electro-magnets (see specification, p. 4, lines 46, 47).

As little as the apparatus of Kennedy's just mentioned can the ring magnet of Werner von Siemens be called a transformer. If, in order to measure a magnetic field, we place in it one or two coils of wire, and observe the current impulse produced by interrupting and closing the magnetising wrapping, we have not thereby constructed a transformer.

This electro-magnet, moreover, is not non-polar, as at the point of impact of the two halves of the iron ring powerful poles are produced.

In order that an electro-magnet or an induction bobbin may be non-polar, the potential loss—*i.e.*, the product of magnetic resistance and magnetic current (*flux de force*) in every longitudinal unit of the magnetic circuit, must be equal to the potential gain—*i.e.*, the magnetomotive force. This is not the case either in the Siemens electro-magnet or in any of the described transformers, except that of Hopkinson represented in fig. 8 of Wilking's memoir. In all these devices the continuity of the magnetic iron is interrupted in several places by layers of air, which have a considerably greater magnetic resistance than a stratum of iron of the same length, whilst the magnetomotive force falling upon this stratum of air = 0, both in the transformer of Whitehouse and in that of Hopkinson and Thomson-Houston, as this air stratum is not encircled by a coil in any of these apparatus.

Strictly speaking, even the transformer of Hopkinson (fig. 8 in Wilking's memoir) cannot be called non-polar, since a part of the iron core is not surrounded with wrappings. Still, I would admit that this apparatus might be considered as an anticipation of that of Zipernowski, Déri and Bláthy had it been made public earlier than the latter. The date, October 28th, 1884, of Hopkinson's application is that of the filing of the provisional description which, according to the English patent law, is kept secret. The publication of this invention ensued only after filing the complete specification, which bears date July 27th, 1885, whilst the German patent of Zipernowski, Déri and Blathy is dated March 6th, 1885. Here, therefore, there can be no pretence of an anticipation, but merely of simultaneity.

If it had been, in fact, Herr Wilking's object on a basis of careful studies to amass contributions to the history of transformers, the point just mentioned could not have escaped him. Certainly he could not have alleged a single anticipation of the Zipernowski-Déri-Bláthy non-polar transformer.

I believe that my explanations will satisfy the unprejudiced reader that Herr Wilking has not intended, according to his title, to collect contributions for the history of transformers, but has aimed at something very different, and I have felt myself compelled to reveal this tendency, and bring it to light.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 504.)

VI.—ARMATURES IN PRACTICE—(*continued*).

21. *Armatures of Class 2 Machines.*—In the dynamos of Class 2 the currents are of a pulsating or fluctuating character in the part of the circuit external to the machine, though always flowing in the same direction. In giving our definition of the dynamo at page 430 (Vol. XXIII.), we stated that in every element of the armature conductor there are induced in each cycle two E.M.Fs. in opposite directions, and that though the current outside the machine may be in one direction, necessarily it is alternating in the coils of the armature. In the dynamos of Class 1, which we have been considering in recent articles, the current in the external part of the circuit alternates exactly as the current in the armature, since the coils of the latter are connected directly to the binding posts terminating the external part of the circuit if the armature is stationary, or through rotating rings and brushes to the binding posts, if the armature rotates.

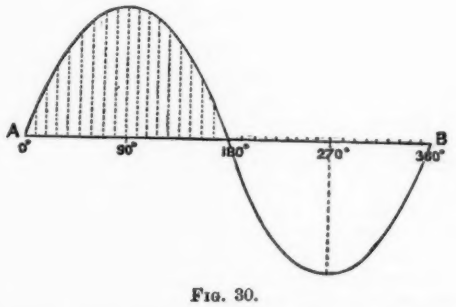


FIG. 30.

The curve of induction for a rectangular frame rotating in a uniform magnetic field we have already drawn in fig. 30, and here repeat for our readers convenience. The frame itself is shown at A, B, C, D, fig. 100, E and F being two metal rings to which the

ends from A and D are respectively attached. N, N, are the lines of force, and the frame is shown with its plane at right angles to the direction of the lines. Just in this position the E.M.F. is 0; it is the position of

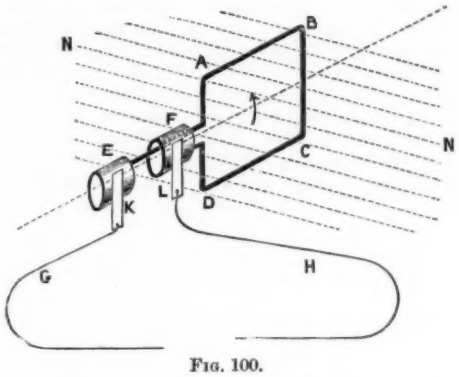


FIG. 100.

reversal, but as the motion continues an E.M.F. is induced which attains its maximum value when the frame has moved through 90° from its first position, and sinks to 0 again when the angle passed through is 180°. From this point an E.M.F. is induced in the opposite direction, which rises to maximum at 270° from the starting point, and falls to 0 when the revolution is completed. The two metal rings, E and F, are insulated from each other and from the shaft. Being fixed concentrically on the latter they rotate with the frame, the external part of the circuit, G, H, being terminated by contact springs, K and L, pressing on them. Evidently these springs are alternately positive and negative, according to the direction of the E.M.F. in the frame. We have consequently an alternating current flowing in the outside part of the circuit, due to an alternating difference of potentials at its terminations.

If we wish the difference of potentials at K and L to be always in the same direction, so that the current will flow in one direction only through G, H, we must have recourse to some device other than that shown for the connection of the moving part of the circuit or armature to the fixed part. Evidently at the instant of each reversal of E.M.F. in the frame the contact springs, terminating the external part of the circuit, must have their connections with the terminations of the rotating frame reversed. If these reversals are effected simultaneously, it is clear that the difference of potentials at K and L will always be in the same direction.

The device employed to connect the contact springs alternately to opposite ends of the rotating frame is of a very simple character, and is shown in fig. 101. Instead of the ends being attached to separate rings, as in fig. 100, they are connected to the two halves of a split ring, E, F. The frame in fig. 101

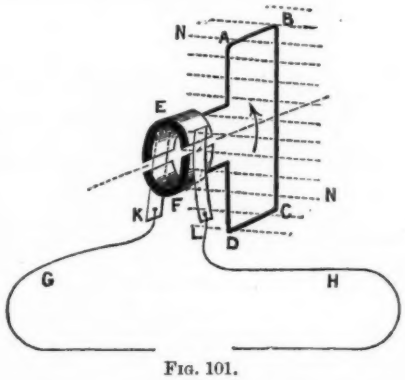


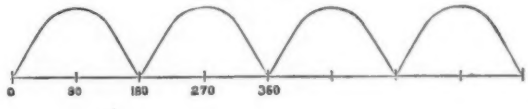
FIG. 101.

is shown in the position of reversal, and it will be seen that the contact springs, K and L, are set so that at this instant the half rings in contact with them are being changed. For half a revolution in the direction of the arrow, that is, while the E.M.F. in the frame continues to be induced in one direction, the half ring, F, is in contact with the spring, L; but at the end of that time, when the E.M.F. is 0, the half ring, E, is brought into contact with L, and remains in contact, while the E.M.F. in the frame is induced in the opposite direction. Thus the spring, K, is always positive or negative, and the current flows in G, H, always in one direction, although alternating in the frame itself. This device of two or more segments employed to give the current a uniform direction in the external part of the circuit is termed a *commutator*.

The induction in the external part of the circuit may be represented by the series of waves in fig. 102. It will be observed that it is subject to the same fluctuation as in fig. 30, varying twice in each revolution between 0 and maximum. The pulsating character of the curve has not been altered in the least by the introduction of the commutator. All that has been done is to establish the difference of potentials in one direction only in the external part of the circuit.

The arrangement just described symbolises the simplest form of direct current machine. Fig. 103 shows a further development in which there are two frames each provided with its own commutator, and placed at right angles to each other. The frame, A, B, C, D, has its ends connected to the commutator, E, while those of the frame, M, N, O, P, are connected to the commutator, Q. The former frame is in the position of reversal, and the commutator plates in contact with K

FIG. 102.



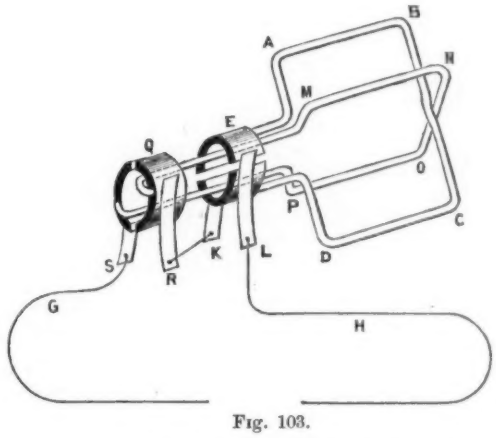


FIG. 103.

and L are accordingly being changed over. The frame, M, N, O, P, being at 90° to the other, is in the position of maximum E.M.F., and the springs, S and R, are therefore in contact with the middle of the commutator plates. The E.M.Fs. of the two frames are added since K is connected to R and the external part of the circuit terminates on L and S. The induction for this combination may be represented by the full line, E, F, in fig. 104, this being the resultant obtained by adding together the E.M.Fs. of the two frames, as shown by the dotted series of waves, A, B and C, D. The variation in the induction when two frames are employed is not nearly so great as when there is only one. Obviously by increasing the number to three or more the variation could be still further reduced.

We have sketched but an ideal machine, and to give it practical shape, certain conditions already explained have to be embodied in the design. Instead of frames consisting of a single conductor we should have to employ coils having many turns of wire. These coils must rotate in a fairly strong field, and to obtain this we must have a magnetic circuit composed almost

wholly of iron, with just enough air gap left for the moving conductors and to ensure them having sufficient mechanical clearance. The practical machine might take the form shown diagrammatically in fig. 105, where we have a field magnet of the double horse-shoe pattern, A, C, D, E, with poles P and Q, between which rotates the laminated iron ring core, R, on which the

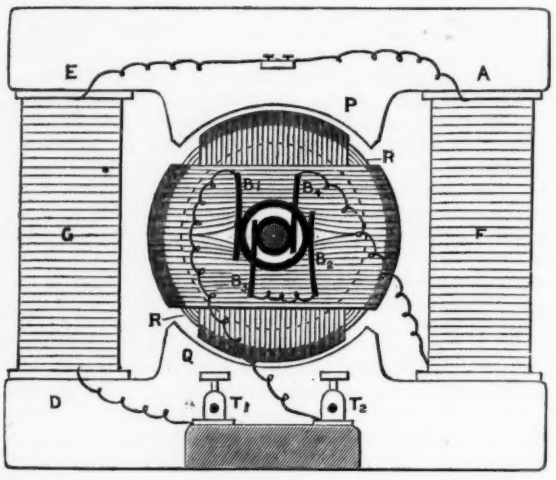


FIG. 105.

two coils at right angles to each other are wound. The two thick circles represent the commutators belonging to the two coils, and by following the connections from the binding post, T_2, it will be seen that the current, after passing from brush B_1 through the first coil to brush B_2 is led to B_3, thence through the second coil to B_4. Since the current outside the armature flows in one direction it is now possible to make it furnish the magnetising force for the field magnets, and accordingly it is led from B_4 through the right hand field coil, F, thence to the left hand coil, G, and through this to the binding post, T_1. T_1 and T_2 terminate the external part of the circuit. Machines of Class 2 are then self-exciting, and are generally connected up so that the current which flows in the external part of the circuit also flows through the magnet coils as here shown. When this mode of connecting the magnetising coils is adopted the machine is said to be *series wound.*

There are in this country at present only two dynamos of Class 2 before the public, these being the Thomson-Houston and Brush machines. Both are series wound and both are employed for arc lighting.

FIG. 104.

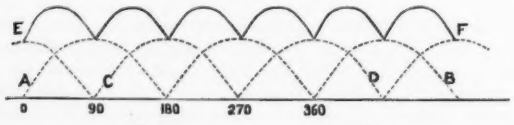


FIG. 106.

In our next article we shall describe the winding of their armatures, meanwhile we may, in concluding the present article, draw attention to one precaution which must be adopted in designing a machine such as shown in fig. 105. If there were only one armature coil it would not matter though at the moment of changing the contact of the commutator plates with the brushes the circuit were momentarily broken, since there is no E.M.F. generated. But when we have two coils it is different. When one commutator is changing over, and no E.M.F. is being furnished by the coil to which it belongs, the maximum E.M.F. is being furnished by the other coil, and the breaking of the circuit at the reversing contacts would therefore give a discontinuous current accompanied by serious sparking. To avoid breaking the circuit it is necessary to have the opening between the two plates running across the commutator at an angle, as in 1, fig. 106, or of the form shown at 2, where they overlap each other. This ensures that there shall be no break in the circuit, for the brush touches both plate A and plate B for part of the revolution. While in contact with both plates the coil is short circuited on itself, but the form of the field is such that there is no E.M.F. generated during the period.

(*To be continued.*)

THE SUBMARINE TELEGRAPH COMPANY.

ON Wednesday evening, in Parliament, when the House went into Committee of Supply on the supplementary estimate of £67,163 for the Submarine Telegraph Company's property required for the Post Office service, Mr. Raikes said that this vote was brought forward in consequence of the abrogation of the concession formerly enjoyed by the Submarine Telegraph Company. There were five sub-heads in the estimates. First, the purchase of the cables themselves, which amounted to £28,300. Two cables between England and Belgium had been purchased for £9,900, and four cables between England and France, including that between Jersey and France, for £18,400. France and Belgium were our partners in the undertaking, and part of the sum would be recovered from them as an appropriation in aid, so that £14,150 would be contributed. There was no difference of opinion between this country and Belgium. But in the case of France there was a considerable divergence of view. The English calculation was £17,000, the French something over £10,000; a compromise was arrived at which fixed the sum at about £14,000. To this was to be added 10 per cent. compensation for the termination of the company's business and what might be termed compulsory expropriation. Subsequently, however, after taking the opinion of an expert, Her Majesty's Government came to the conclusion that £17,000 was not too high a price, and the French Government, in a handsome and generous spirit, which he desired fully to acknowledge, at once acceded to the increaso of price. The result was that the estimate appeared at £18,400. The other items were buildings, cableship, instruments and stores, and fees of valuers, £46,763. The sub-items were £24,679 for the 80 years' lease of a building in Throgmorton Avenue, erected only nine years ago, and capable of accomodating 300 persons; £9,542 for apparatus, gas engines, and pneumatic tubes; £9,570 was paid for the cableship *Lady Carmichael*, which was as good as new and classed A1 at Lloyd's. This was a most reasonable price, as the cableship which we had for the stormy seas on the coast of Ireland cost £40,000.

Mr. Henniker Heaton moved the reduction of the vote by the sum of £28,300, the amount of the two items for the cables, and afterwards by another £5,500, the amount of bonus to be paid to those officers of the company not taken into the State service.

When the committee divided the majority against the reduction of the vote was 93, and the vote was therefore agreed to.

NOTES.

Erratum.—In the reproduction of Mr. Gelyi's article there is an error in the translation from the German. On p. 557, for "they far prefer Deri's parallel introduction to their own series introduction," read "they far prefer their own series introduction to Deri's parallel introduction."

Huddersfield and the Electric Light.—The Corporation have received a petition from the inhabitants for the lighting of the town by electricity.

Electric Light in War.—The English Mediterranean fleet and the shore batteries of Malta had a midnight engagement last Saturday, in which the electric search lights figured extensively. The function was arranged to test the power of the electric lights through clouds of smoke, and the result was that the electric lights cannot successfully pierce cannon smoke.

Electric Lighting in Munich.—An electric light plant has been installed in the new hall of the Trades Association of Munich. There are six arc lamps in front of the building, and 170 incandescent lamps inside. An Adam gas engine of 25 H.P. is employed. The work has been carried out by the Allgemeine Elektricitäts Gesellschaft.

Electric Lighting at Exeter.—The company which has been formed for the supply of electric lighting in the City of Exeter is making satisfactory progress with the work of erecting suitable machinery at the central depôt in New Bath Road. An offer has just been made to tradesmen first and afterwards to private residents to light their premises free of charge for the first two months of the experiment.

Ship Lighting.—Amongst the ships recently fitted with the electric light by Messrs. Paterson and Cooper are the screw steamers *Islander*, *Curfew*, *Ardle*, *Dundee*, *Cambria*, *Pladda*, *Deans*, *Modjeska*, and the steam yacht *Tighnamara*, belonging to Mr. Allan, of the Allan line of steamers. The firm has several ships on hand, including the ss. *Red Sea*, and ps. *St. Magnus*.

Dangerous Electric Currents.—We have received a copy of a pamphlet, written by Mr. Harold P. Brown, on "The Comparative Danger to Life of the Alternating and Continuous Electric Currents." We are sorry that it arrived too late for us to do more than to give it bare mention in this issue.

The Compound-Winding Case.—The action of King, Brown & Co. *v.* Anglo-American Brush Corporation, came on for hearing again on Wednesday. The day was occupied by Mr. Graham Murray for the pursuers, and this gentleman's speech will be reported in our next issue. Possibly by that time judgment will have been given, for such matters are, we believe, settled more quickly across the border than in England.

A Powder Magazine Blown Up.—An extraordinary catastrophe, happily unattended by loss of life, occurred the other night at Koenighstein, Saxony. The military powder magazine belonging to that fortress was struck by lightning, and instantly exploded with a terrific noise. Several hundred shells were stored in the magazine. In view of Colonel Armstrong's remarks in discussing Dr. Lodge's paper, it would be very interesting to learn what precautions against lightning had been taken in this case.

Society of Arts.—On Monday, May 27th, at 8 p.m., Mr. H. Graham Harris, M.I.C.E., will continue the "Cantor Lectures," on "Heat Engines other than Steam." His subject will include petroleum engines, electrical heat engines, and the Edison thermopile. On Tuesday, May 28th, at 8 p.m., a paper on "The Westinghouse Alternating System of Central Station Electric Lighting in the United States of America," will be read by James S. Humbird. W. H. Preece, F.R.S., will preside.

Institute Electrical Engineers Students' Meeting.—At a meeting held on Friday, May 17th, Mr. Sydney Evershed, A.I.E.E., in the chair, a note was read by Mr. R. W. Paul on "Increasing the fog penetrating power of the arc light," and a note by Mr. J. N. Cooper on "Equi-potential surfaces." A discussion followed, in which Messrs. Yeaman, Horn, and the chairman took part. A vote of thanks to Mr. Evershed closed the proceedings.

Lighting the Albert Institute, Dundee.—The free portions of the Albert Institute, Dundee, will be electrically lighted through the generosity of Mr. Dalgleish, of Errol Park, Perthshire, who has offered the sum of £1,000 for providing the necessary plant. Mr. Dalgleish, we may add, has had his own house lighted by incandescent lamps for the past three years, and he strongly advocates it generally in preference to gas.

Aberdeen as a Telegraphic Centre.—On account of the growing importance of Aberdeen as a telegraphic centre, the Treasury have sanctioned a considerable increase to the staff. At present it numbers 74 clerks, 13 of whom are ladies, and the addition is to consist of eight men telegraphists (two first class and six second class).

Telegraph Cable Subsidies.—In reply to questions in the House of Commons on Friday, Mr. Goschen said, roughly speaking, the total cost of telegrams for the various departments of the Government during the year were something under £16,000. Last year votes showed that subsidies amounting to £49,000 net were paid by the Imperial Exchequer to submarine telegraph companies. He understood that the Eastern Extension Telegraph Company had laid two cables to Australia. The one which was first laid was unsubsidised, but the Australian Colonies paid an annual subsidy of £32,400 for the second.

Execution by Electricity in America.—It is now stated that three men condemned to death will be finished off by the new method in a couple of weeks. The executions are to be conducted in private.

The Société l'Electrique.—The report of this Belgian company states that matters are very prosperous. The working of the electrical system on the Brussels tramways leaves nothing to be desired. In addition to the sale of accumulators, they have gone in for installation work, such as that in the Palace of the Count of Flanders. A dividend of 5 per cent. has been declared, after allowing for depreciation, &c.

Electrical Engineering in Austria-Hungary.—There appears to be a good business doing in this part of the continent. The British Consul at Buda-Pesth states that the well known firm of Ganz & Co. last year had orders for 108 electric lighting plants, with 560 arc lamps and 54,000 glow lamps. Of these plants, 27 were for Hungary, 15 for Austria, 23 for Spain, 12 for France, 3 for Russia, 10 for Italy, 4 for Germany, 5 for Australia, 4 for South America, and one each for Sweden, Switzerland, Belgium, Servia and Portugal. The firm has further contracted for electric lighting in Rome, Lucerne, Barcelona, Moscow, Montevideo, Valencia, Monte Carlo, Nice, &c.

Standardising Electrical Instruments.—A meeting of the Standardising Committee of the Institution of Electrical Engineers was announced to be held at the Royal Society, Burlington House, yesterday, at 3 p.m.

Electric Railway Proposed.—On the invitation of some of the leading gentlemen in Brechin, Mr. A. R. Bennett addressed a public meeting in that town on May 16th on the subject of electric railways, and more especially in connection with a proposed line from Brechin to Edzell, a distance of six miles. There was a large attendance, and the meeting resulted in the appointment of a committee consisting of Provost Mitchell; Mr. Shiel, factor to the Earl of Dalhousie; Mr. Lamb, manufacturer; Mr. Valentine; Mr. Anderson, and Mr. Philip, Bank of Scotland, to procure estimates, and approach the proprietors whose land is required, with the view of avoiding, if possible, the necessity of an Act of Parliament.

Finsbury Students' Conversazione.—At the *conversazione* held yesterday and to be continued this evening at the Finsbury Technical College, Messrs. Paterson and Cooper have an exhibit illustrating the manufacture of dynamos, and showing the method of constructing their armatures from the beginning. They also display a variety of their measuring instruments, including ammeters for the measurement of currents up to 1,200 ampères, voltmeters, galvanometers, and bridges. Several of their latest forms of switches, fuses, and other electric lighting accessories have also a place at their stand.

An Interesting Find.—In going over some old papers which had been thrown into a cupboard in the City Library at Bologna, Signor Tartarini, the librarian, has discovered a manuscript of several pages by Galvani, dealing with electricity.

Sebastopol.—The municipality of this town has decided to instal the electric light. Tenders will be invited shortly.

Another Primary Battery Coming. — It is said that another "boom" in primary batteries is about to make itself felt. From the information we can gather, the system consists mainly in emptying half-spent liquids from one set of cells into another, and this process to be repeated into still a third. We also learn that it has been reported upon, both unfavourably and favourably, by a well-known expert, and that the Steinway Hall has been engaged as a centre from which to exploit the invention. Our readers may rely upon it that at the first opportunity we will thoroughly investigate the scheme.

Reconversion of Waste Products in Batteries.—Manchester now seems to be the headquarters of the continually revived schemes for the reconversion of spent liquids in primary batteries. The *Manchester Examiner* describes at some length the operations—or, shall we say the proposed intentions—of the General Zinc Recovery and Lighting Company, Limited, which has opened an office in Deansgate. We can see nothing in all this which has not been tried in London and found wanting. Will the time ever come when these so-called valuable processes are treated in the way they so well deserve, or will the British public, like the brook, go on for ever without being able to sift the grain from the chaff in matters electrical?

Something Wrong.—The following estimates for the erection of an electric fire signal system at the School and Asylum for Imbeciles, Darenth, Kent, is highly instructive :—

Binks and Co., London	£749	10	0
F. J. Lovett	625	0	0
Bailey and Grundy, London...	558	0	0
Strode and Co., London	540	0	0
J. Sax, London	488	0	0
Wadley Bros.	473	8	0
Cox, Walker, and Co., Darlington	438	8	0
Harrison and Co.	420	0	0
Blenheim and Co., Egham	398	0	0
Fowler, Lancaster and Co., Birmingham ...	369	10	0
Spagnoletti and Crooks, London	348	0	0
Gent and Co., Leicester	333	0	0
Dale and Co., Limited, 26, Ludgate Hill, E.C. (accepted)	318	0	0
J. Blackburn, Nottingham	299	16	5

Parkes v. Moross.—Dr. J. Reginald Jones, of Birkenhead, has sent us for publication a long letter on the merits of the suit, Moross *v.* Parkes. This makes the sixth we have had from doctors, clergymen and others in defence of Mr. Parkes, who is described, and we should think justly so, as a gentleman of high standing, unimpeachable honour, and sterling integrity. Dr. Jones admits that the Southport medical electrician unwittingly overstepped the bar erected by law, and this we should assuredly do were we to print his communication. Mr. Parkes has entirely upheld his reputation, and we think that enough has now been said upon this matter.

Insulting the President of the French Republic by Telephone.—The man who, on May 6th, as we stated in our last number, insulted the President of the Republic through the telephone, has been arrested by M. Clément, and temporarily taken to the station. He is a shopman named Poigny, in service in the Rue des Archives.

Lights Wanted in Shanghai.—The Council of the Municipal Administration of the French Concession at Shanghai (China) submits for competition the lighting of the concession by means of a system which shall commend itself as the best for its lighting power and actual cost. The present undertaking to date from April 1st, 1891, for a term to be decided upon for each tender. Tenders must be written in French or English, and must be sent in sealed envelopes to the secretary of the French Municipality of Shanghai (China) before December 31st. For particulars of specification and all other information apply to the Engineer of the French Municipality at Shanghai; or to Mr. A. Servant, 6, Rue de Braque, Paris. Competitors have plenty of time in which to get out estimates and prepare plant.

Alternating Current Working.—Mr. Mordey's paper, which was read last night at the meeting of the Institution of Electrical Engineers, is certain to teem with valuable facts, and some of his observations will be found to be directly contrary to generally accepted theories. For instance, Mr. Mordey says he was very unorthodox when, in 1886, he asserted that self-induction was not a virtue to be cultivated in motors any more than in dynamos. Now he is prepared to take a precisely similar stand with regard to alternators, and submit the view that a perfect alternator for any and every purpose should have no resistance and no self-induction. He admits that if the tendency of the prime motor to lead or to lag is so great that under no circumstances can it be controlled, then large self-induction or resistance may be of use in order to prevent one or more of the machines being burnt up; or, as he pithily concludes, self-induction is useful because it prevents the machine which ought not to have it from being burnt up because it has it.

Combination.—Henceforth "The Electric Light and Power Supply Company of Australia, Limited," and "The Southern Electric Company, Limited, of Melbourne," are to be run as one, under the title of "The Union Electric Company of Australia, Limited."

Electrical Testing Club.—A correspondent writes that he has what he terms a comfortable electrical laboratory and a considerable amount of apparatus. He is desirous of forming a club for the purpose of conducting electrical experiments, there being special facilities for researches into the phenomena of static electricity and for working at lightning conductors.

Personal.—Mr. Francis Simmons (late Charles J. Simmons), manufacturer of electrical test instruments for land and marine service, informs us that it is his intention to carry on the business formerly conducted by his brother, whose untimely end we notified in our issue for the 10th inst. Mr. Francis Simmons has already been associated with the business for the last six years, and we wish him success and prosperity in his undertaking.

We learn that Mr. J. Slater Lewis is about to throw his energy into the business of Messrs. Buller and Jobson, of Birmingham, presumably into the electrical department of that firm.

The Postmaster-General and Telegraphic Addresses.—Mr. Raikes, in reply to a question in the House of Commons on Tuesday, said: There are at the present time about 35,000 telegraphic addresses registered at the Post Office, and the fees amount to about £37,000 per annum. It is impossible on such short notice to give an estimate of the cost of keeping the register, and such information, if furnished, would be of little use. The cost of keeping the register forms only a portion of the expense to which the Post Office is put in connection with the registered addresses. In the case of messages with such addresses, references have to be made to the registers before the messages can be delivered, and these references cost more than the mere "keeping" of the register.

Lucigen Lights and Fire.—During a disastrous fire at a Dumbarton ship building yard, owned by Messrs. A. M'Millan and Son, the oil tanks of two lucigen lights exploded with loud reports and assisted greatly the work of destruction, one of the lamps ascending into the air to a great height. It is hardly necessary to say that had electric lamps been used the disaster would have been partly averted.

The New Submarine Boat.—A Central News telegram from Madrid says that the new submarine boat *Peral*, which we have frequently referred to in our columns, is now ready, and immersion trials will begin directly. The officers of the *Peral* have received £20,000 from a Spanish gentleman residing in Buenos Ayres as a testimonial of his admiration for the success of the new venture and for defraying the expenses of any further experiments. The Admiralty is deeply interested in the experiments.

Overcoming a Difficulty.—At the recent soirée of the Architect's Association gas could not be used for the footlights, owing to insurance. The Acme Electric Works Company overcame the difficulty, however, by lighting the stage with incandescent lamps, using 12 accumulators. An adjustable resistance was also inserted in circuit, so that the brilliancy of the lamps could be varied as desired.

The Society of Arts Motor Trials.—The report of these tests of steam and gas engines, with the addition of Prof. Kennedy's extra paper on "The Objects and Methods of the Society of Arts Motor Trials," have been reprinted in pamphlet form. Its price is 1s., and it can be obtained on application to the secretary. We think that this little *brochure* should be in the hands of everybody interested in motive power.

The London Central Subway.—In the House of Commons on Wednesday, Sir Frederick Bramwell was called as a witness before Mr. Woodall's Select Committee on the London Central Subway Bill. Sir Frederick opposed the Bill on the ground that the route was not well selected, and that the electrical plant estimated for by the promotors would be insufficient, and that if adequately increased the working expenses would in consequence be greater than anticipated.

The Weymersch Primary Battery.—This battery, which our readers will remember as having given such excellent results, is now on the market, through the medium of the India-Rubber and Gutta-Percha Company, of London and Silvertown. Every information respecting this really genuine improvement, for which no impossibilities are claimed, can be obtained on application to the Company.

Telephonic Amalgamation.—The difficulties in the way of the amalgamation of the three telephone companies in the United Kingdom have now been overcome. The amalgamation will be effected by one of the companies purchasing the other two, giving them shares as the purchase price.

NEW COMPANY REGISTERED.

Taylor and Tucker Art Metal Company, Limited.—Capital £5,000, in £1 shares. Objects: To manufacture art metal work, including the supply of gas and electric light, and fittings for the same; also to manufacture and supply electric and other bells. Signatories (with one share each): T. H. Fidgeon, Northumberland Park, Tottenham; A. W. N. Stuart, 10, Ancona Road, Highbury; S. Jordan, 36, Gertrude Street, Fulham Road; W. Eacott, 29, Powell Road, Clapton, E.; G. E. Tucker, Berwick House, Ashmore Road, W.; F. A. Bettingham, 41, Baker Street, W.; J. Taylor, 22, Rutland Street, Hampstead. Registered 10th inst., without articles of association, by Deacon and Co., 4, St. Mary Axe, E.C. Registered office, 9, Duke Street Mansions, Grosvenor Square.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Date and Time Stamp Company, Limited.—The capital of this company has been increased by the addition thereto of 21,000 shares of £1 each beyond the registered capital of £100,000.

An agreement of 15th inst., between the company and D. J. Williams, of 19, St. Swithin's Lane, and William Brown, of 7, Queen Victoria Street (the vendors), provides for the allotment to the vendors of 17,667 fully paid up shares of £1 each.

An agreement of 15th inst., between the company and Charles Adam Randall, of 26, Church Street, New York, electrical engineer, provides for the allotment to the latter or his nominees of 3,333 fully paid shares, in consideration of the assignment of certain inventions.

Electric Galvanic Machine Company, Limited.—The statutory return of this company, made up to May 10th, was filed on the 15th inst. The nominal capital is £3,500, in £1 shares. 2,900 shares are taken up, and 1,800 of these are considered as fully paid. 10s. per share has been called upon 1,100 shares, the calls paid amounting to £497, leaving £53 unpaid. Registered office, 88, London Wall.

Crompton-Howell Electrical Storage Company, Limited.—An agreement of the 3rd inst., between Rookes Evelyn Bell Crompton and J. F. Albright, both of Chelmsford, and John Charles Howell, of Llanelly, Carmarthen (the vendors), of one part, and the company of the other part, provides for the purchase of the leasehold premises, plant, machinery, and goodwill of the business of manufacturing secondary batteries carried on by the vendors. In consideration of the purchase, the company will issue jointly to Messrs. R. E. Bell Crompton and J. F. Albright three founders' shares of £100 each, and 6,000 ordinary shares of £1 each, and to Mr. Howell three founders' shares and 2,000 ordinary shares. The said founders' shares are to be considered as fully paid, and the ordinary shares paid up to the extent of 15s. per share. Registered office, Mansion House Buildings, Queen Victoria Street.

Medical Battery Company, Limited.—An agreement of 1st inst. provides for the sale to the new company of the business of the former company with the same title. The new company will discharge the debts and liabilities of the old and will allot one fully paid new share in exchange for each share in the old company.

New Telephone Company, Limited.—At an extraordinary general meeting of the shareholders in this company, held at 4, Great Winchester Street, on the 27th ult., it was resolved to wind up, it having been proved that by reason of its liabilities the company cannot continue business. Mr. Wm. Slingsby Ogle, of 90, Cannon Street, accountant, was appointed liquidator. The resolution was duly filed on the 3rd inst.

St. James's and Pall Mall Electric Light Company, Limited.—The annual return of this company, made up to the 30th ult., was filed on the 16th inst. The nominal capital is £100,000, divided into 100 shares of £1 each, and 19,980 shares of £5 each. The whole of the £1 shares, and 5,103 of the £5 shares, have been taken up, and the full amount has been called thereon. The calls paid amount to £25,613, leaving £2 unpaid. Registered office, Mason's Yard, Duke Street, St. James's.

Metropolitan Electric Supply Company, Limited.—The registered office of this company is now situate at 259A, Winchester House, Old Broad Street, E.C.

Planet Electrical Engineering Company, Limited.—The registered office of this company is at 2, Victoria Mansions, 28, Victoria Street, Westminster.

CITY NOTES, REPORTS, MEETINGS, &c.

The Western and Brazilian Telegraph Company, Limited.

THE seventeenth ordinary general meeting was held last Thursday at Winchester House, Old Broad Street, Mr. W. S. Andrews, chairman of directors, presided.

The Secretary, Mr. R. M. Cunningham, having read the notice convening the meeting and the minutes of the last ordinary and extraordinary meetings, the report, which was published last week, was taken as read.

The Chairman then said: It has been my pleasing duty on the last few occasions that the shareholders have met, to congratulate them upon the continuous increases in traffic with which the concern has been favoured. I am very pleased to say that to-day forms no exception. The traffic for the last half of 1888 is the largest traffic that we have ever had in any one half-year since the undertaking was formed. The corresponding half-year was a very satisfactory one, but the last shows, as compared with that, a receipt of £112,250, the previous receipt having been £78,369, the increase at December, 1888, as compared with December, 1887, being, therefore, £33,881, or just 43 per cent. That, of course, is eminently satisfactory. It appears to me that it will be equally satisfactory to you to learn that that large increase of nearly £34,000 has been earned at no very largely increased expenditure. I do not know that companies generally can haul in so large a receipt at such a comparatively small increase of expenditure. Analysing the increases and decreases we find, as we may expect, that the increase has arisen at the stations abroad. Salaries and wages account for £1,235 of the increase, which is attributable largely to increased payments on account of the high rate of exchange, which you have heard of previously, to an increase of staff, and to a bonus which the directors had to give to the staff on account of the expense of living; and seeing that these men did the actual work of earning the increase of nearly £34,000, I do not think you will object to that. In the miscellaneous expenses there is an increase which is mainly on the head of exchange, rent and taxes, &c. The other items are very small. In Abstract B, relating to the cost of ships, we have an increase of £837, nearly all for additional stores supplied to the *Norseman*, and a decrease of £1,020, arising from lessened expenditure on account of coal, making a total decrease of £183; but we were fortunate enough to effect charters both for the *Viking* and *Norseman*, from which we derived the sum of £1,323, so that taking that amount with the other saving, we find a reduced expenditure on account of ships of £1,506, compared with the corresponding period. Under Abstract C (expenses at home) which shareholders —and, I think, very rightly—look at with a considerable amount of attention, there is an increased expenditure of £93, which is simply the result of increased business. Thus, the outcome of an examination of the accounts is, I take it, not unsatisfactory. On April 1st considerable reductions were effected in the rates between this country and Brazil, in order in the one direction to develop the communication, by telegraph, between this and the neighbouring countries, and in order also to satisfy customers. Customers appear to have, what was termed by Mr. Disraeli, "an ignorant impatience of taxation." In cases of this kind customers always call a tariff high, and always want a lower one if they can get it. We had hoped that by the time this meeting was held we should have been able to tell you something as to the effect of that reduction in the tariff, but, most unfortunately, our line between Pernambuco and Rio broke down on March 31st. As if that were not sufficient, the line broke between Rio and Santos on April 15th, and on the very day after the repair of the first breakage, the line broke down between Rio Grande and Chili, and although every expedition was used, of course the mere steaming to the scene of the accident took up a considerable time. However, the breakages were all repaired on May 11th. It is impossible for us at present to estimate what share of the loss of traffic has been occasioned by the interruption, and what share of the lessened receipts is due to the new tariff. We have, however, arrived at one conclusion—that these accidents prove the necessity and wisdom of the policy which you, gentlemen, determined to carry out of laying loop cables; for if these loops had been actually down instead of projected, you would, in all probability, have been in the enjoyment of your full revenue. There is no doubt that the security of communication afforded by these loops tends to develop trade, and is an encouragement in the direction of an increase of business. With regard to these loops, of which, as I have said, the shareholders have already warmly approved, the directors had to look about them to see in what way they could effect the laying of those loops. The first thing that struck us was that we had £50,000 B debentures unissued, which would rank with the existing B's as regards charges, and which would stand pretty well as to terms for issuing, because you must not suppose that the directors are dreaming of issuing these debentures at 6 per cent. interest. Then the directors considered whether they could issue more debentures. They thought not; because this would constitute a fresh charge, and an additional incubus. The same objection applied to preference shares. They could not issue ordinary shares, for the ordinary shares are at a discount, and, as the courts have recently held, it is not legal to issue such shares at a discount. Thus the directors were driven back, by a process of exhaustion, to two methods. One was to issue £50,000 debentures, and take the rest that might be required from the reserve fund; but, considering this, they found it would have too great a tendency to weaken the soundness of our financial position, and consequently, after very careful consideration, they arrived at the resolution that has been communicated in the report to the proprietary body. There was on one side of the account a very unsatisfactory item of £26,100 discount on the old issue of debentures. That was not an item which would have assisted the board in any reorganisation of the debentures, for they must have got rid of it before they could effect any such reorganisation; but in so disposing of it they would dispose of an annual charge of £1,200. Taking the sum of £36,000 provided by repayment made to capital account, and the £1,200 which would be due in respect of directors' fees of the Platino Company, and including the £50,000 which might be raised by debentures, the directors thought they saw their way, without issuing further capital, to raising a sum of nearly £90,000. The balance of that amount required for the work might, they thought, be properly taken from the reserve fund. Of course, this will not be all required at once. The first operation that we should bring into effect would be to use the cash that we have; the second would be the sale of a certain number of securities from the renewal fund; and the third would be the issue of debentures. All these debentures would be, of course, offered to our own proprietors. There is no necessity to go outside the proprietary body, and I should hope that a good many of you, gentlemen, will come forward and take these debentures yourselves. It is very satisfactory to see this—that the whole of this great addition to your system will be made at the cost of the interest of the £50,000 debentures, less the £1,200 a year which you save —a cost which, I may say, is extremely small. There will, of course, be the loss of dividends on the securities that are sold; but I am very pleased to observe that these securities stand at a much higher price than they did when we bought them. We have not, of course, been able to go further with respect to these loops than to consider the best way in which they might be laid; and we can, of course, do nothing more until you approve of our plans, as I hope you will. The operation we shall have to perform will be a little complicated. We shall have to send out one expedition, in the first instance, and that may be followed by one or two more. It may be advisable to make a contract to make and lay, or simply a contract to make, and lay ourselves, hiring the ships ourselves. When we have your authority, we shall set to work and put the matter into shape in one form or another. With regard to the position this will put us in, although, as you see by the report, we have been advised that any reorganisation of the debentures is subject to the sanction of the debenture-holders, we are not disposed to despair of that measure. We have consulted several gentlemen whose opinions are worth having, and they do not take at all a discouraging view of the case. They say the tendency now in the direction of a more permanent security, coupled with a lower rate of interest, is so great that they think our measure would have a very good chance of success; and we are disposed to think so too. All we are doing now is to clear the way. We have endeavoured to make our position sound, and, with these inducements, we think that the debenture-holders, knowing that during the next few months these debentures may be drawn at par, may prefer a permanent investment at a lower rate of interest. There is one subject I should be very happy not to have touched upon, but I am bound to do so to a certain extent, because we have had to address a flyleaf on the matter accompanying the report to the shareholders. We were informed, quite by accident, that a circular had been issued to a number of shareholders, inviting them not to give their proxies to the board, but to certain gentlemen who were named. Of course, in the abstract, there is no reason to complain of that. But in this case this meeting which we are now attending was actually not fixed. The result of the half-year was not known—it had not appeared; nobody knew what it was. The report to be made by the directors had not been settled, and therefore those gentlemen who gave their proxies as asked were in the extraordinary position of being in opposition to our report without knowing what it was, and without having favoured us with any communication on the subject, or telling us what their opinions were, but simply on account of their confidence in the gentleman who issued the circular. They sent him a very large number of proxies, representing, I think, something like 13,000 votes. Of course, I do not mean to imply for one moment that these gentlemen have anything in view but the good of the concern. All I can say is that it would have been a little more courteous and would have had a better result if they had come to us and told us their views. This case is one which shows the necessity of proxies, for, if we had not heard of this by a mere fluke, they might have come down to this meeting and carried their policy in spite of the opinions of proprietors who had been for years in the company. As it is, the board is now amply provided with proxies. In conclusion, the chairman, after referring to the proposed construction of loop cables as calculated to check opposition, moved the adoption of the report and accounts, and the declaration of a dividend of 9s. per share.

Mr. Weaver seconded the motion.

Mr. Gaston criticised various items in the balance sheet, and, amid cries of "Time," moved three amendments on points of detail, which, however, were not seconded.

Mr. Grover asked whether the present cable was in a sound condition, and whether the proposed sum of £90,000 would cover the cost of laying the necessary 1,500 or 1,600 miles of cable.

The Chairman replied in the affirmative. The cable was in a perfectly sound state, all three of the accidents referred to having arisen from mechanical causes.

Mr. Coffin, who also took exception to the financial arrangements proposed, moved as an amendment:—"That the sum of £16,000

be taken from the debenture redemption fund towards the payment for loop cables, and that the balance, if any required, be taken from the renewal fund balance."

Mr. Wedgwood seconded the amendment.

The Chairman said he understood that Mr. Coffin was the representative of the gentlemen to whom he had referred as having asked for proxies in opposition to the board. The directors, however, had been favoured with more proxies than they had ever had before. The proprietors, after full knowledge of what the directors proposed, had sent them 30,375 votes, and 1,973 more votes had arrived too late for registration. He should, if necessary, use these proxies in support of the resolution, the amendment being distinctly opposed to the policy of the directors.

After some further discussion, the amendment was put to the meeting, and lost by a large majority, only 12 hands being held up in favour of it.

The report and accounts were then adopted. Lord Richard Howe-Browne and Mr. Goodsall were re-elected directors.

Mr. Pike moved the re-election of Mr. Weise as auditor, with an increased remuneration of 100 guineas, in consideration of the balance sheets being now made out half-yearly instead of yearly.

Mr. Gaston moved, as an amendment, that Mr. Griffiths (Deloitte, Dever & Co.) be appointed joint auditor with Mr. Weise, the fee of 100 guineas to be divided between them.

The amendment was seconded by Mr. Coffin (who complained that no notice had been given of the proposed increased remuneration), and, on a show of hands, was carried by 26 to 5.

A vote of thanks to the chairman terminated the proceedings.

Elmore's Patent Copper Depositing Company.

THE first ordinary or statutory meeting was held on Friday at the City Terminus Hotel, Cannon Street, Sir John Morris, K.C.S.I., in the chair.

The Secretary having read the notice convening the meeting,

The Chairman said: Gentlemen, you are doubtless aware that, this being only a statutory meeting, there are no accounts to place before you and no resolutions to pass, and, moreover, no report to be read; at the same time I have some remarks to make, and some information I am anxious to give you. Your directors are glad to have this opportunity of meeting you, though we have deferred calling this meeting to so late a date to enable us to report the fullest possible progress to you. The company was registered on January 18th last, and the allotment letters posted on the 25th of that month. The number of shares offered to the public was 46,700, and applications were received for over 160,000, the amount paid on deposit being upwards of £40,000. The whole of the issue has, therefore, being allotted, and there is practically nothing outstanding. You will remember that in the prospectus it was stated that the company had secured works near Sheffield, but this left us the option of rejecting them if others were found more suitable. After deliberation, however, we considered that the proposed works not being sufficiently well placed for cheap carriage of goods, it would not be advantageous to accept them. Endeavour was, therefore, at once made to secure a convenient piece of land in the neighbourhood where most of our work will be found, and it was not till after the lapse of some considerable time that we were able to select a suitable site near Leeds. This land is most conveniently situated on the Aire and Calder Navigation Canal on the one side and the Midland main line on the other, with which we shall, at an early date, be connected by a branch siding. The rates, also, for the delivery of our raw material to the works, and for the despatch of manufactured goods, could hardly be more favourable than they are in respect of our new works. After this land had been brought to our notice, the negotiations with the landlords' agents were necessarily very protracted, and it was not until a fortnight ago that they were finally completed. The delay was unavoidable, but we consider that we have secured this land, nearly six acres in extent, on very advantageous terms, and which include the option of purchasing the freehold at any time during the next seven years. Contemporaneously with these negotiations, the management has been arranging to obtain tenders for the erection of suitable buildings, &c., and the contractor has already commenced the erection of the same, and undertakes to have them completed by the end of June. Orders for the necessary plant and machinery have also long since been placed, and will, so far as we can see, be ready for delivery by the time our buildings are ready to receive the same. Almost immediately after the company was formed negotiations were opened up with us from a responsible group of capitalists proposing a lease of this company to them upon very advantageous terms. These terms were very carefully considered, and, after due deliberation, were declined, inasmuch as we are convinced that under the present management the company is able to do equally, well, and, indeed much better than it would by surrendering itself to the control of outside parties. In connection, however, with these negotiations, some preliminary tests and experiments were carried out under the immediate and careful supervision of our managers, and some tubes were produced which, upon testing, have yielded the most gratifying results; and, so far as it is allowable to judge of the process from this small scale, there can be no reasonable doubt that the process is as valuable and profitable as was foreshadowed in the prospectus issued to the public. Some of these tubes are laid before you today for your examination, and what makes these more noteworthy is the fact that the plant used in their production was of a somewhat obsolete character, and not so reliable as that about to be installed at our new works. To enable you to judge of the success of these experiments, and the commercial value of the Elmore process, I will give you one or two extracts from the report made upon the trial in question:—"I am glad to be able to state generally that the good opinion formed by me after the preliminary test has been strongly confirmed by the result of the more extended and complete trial. Greater attention has been paid to the measurements of important quantities, greater regularity of working has prevailed during the tests, and every attempt has been made to test thoroughly the statements made by the Messrs. Elmore as to the quantity and quality of the metal produced by them in the form of tubes, and also as to the practical working of certain details intimately connected with the commercial success of the process. I have only to say, in conclusion, that the demonstration has been an unqualified success, and that I am more than astonished at the simplicity of the process by which such remarkable results are obtained." From all this, it will, I trust, be evident to you, as it is abundantly evident to us, that in the Elmore copper depositing process we have an invention destined to take a leading position in this country, and from which there is every reason to believe very large profits must be derived. It is also very satisfactory to know that the rise and fall in the price of copper does not materially affect the prosperity of this company, though, of course, the lower the price of copper the larger the business likely to be done. The board now consists of eight directors, four additional members having been elected since the promotion of the company, viz., Mr. F. L. Rawson, of Woodhouse and Rawson, Limited, whose technical knowledge is most valuable to the company; Mr. G. C. V. Holmes, and Messrs. J. J. Atkinson and J. T. Cooper, the two latter gentlemen being the representatives of the vendors. Application was made to the Stock Exchange for a settlement and quotation directly after allotment, and we were informed that the same would be entertained as soon as £50,000 of the company's capital had been paid in cash. This was the case as soon as the call was due, and our brokers were instructed to renew the application; and the particulars required by the committee of the Stock Exchange having been furnished some few days ago, we see no reason why there should not be an early appointment of a special settlement of the company's account, and an official quotation of our shares. The company's managers, Messrs. F. E. and A. S. Elmore, are busily engaged in connection with the erection of the works and installation of the plant, and trial tests already referred to by me were carried out under the supervision of these gentlemen. I think it only right that I should read you an extract from the report referring especially to their services. It is as follows:—"I have to tender my thanks, through you, to the Messrs. Elmore, for the invariable courtesy and openness shown by them to me, and to congratulate them upon the remarkable success and ingenuity shown by them in the carrying out of the details of the process, as well as the eminently scientific method of arriving at the constants which will produce the best results. It is only due to them to say that the demonstration has been an unqualified success; and such small disasters as have occurred have only shown me how capable they are to deal with difficulties, and how thoroughly they have made themselves acquainted with the details of their work." I think you will concur with me in regarding this as very satisfactory, as well as holding out good promise of our future success. In conclusion, I have only to say that the arrangement of details of the business of this board is now divided amongst two or three committees, thus ensuring each member of the board being brought into personal contact with the details of the work, and also securing a better supervision of the company's interests. If any shareholder has any questions to ask, I shall be glad to answer them.

General Light said he saw Mr. Stepney Rawson present, and he believed he had been in France, and had seen the working of the process. He thought any information he could give them would be interesting.

The Chairman suggested that if any shareholder had any questions to put, it might be well to put them before Mr. Stepney Rawson made any remarks, as he might cover them.

A Shareholder asked if there were any boilers in practical working fitted with these tubes at present.

Another Shareholder asked if the contract the chairman mentioned as having been refused was for British industry or foreign.

The Chairman said for British industry.

Another Shareholder said he noticed that a certain firm were making arrangements to carry on the system on a royalty. He should like to know if they were carrying it out.

The Chairman said: Until they had their own works, and could see the results, they thought it better to defer the conclusion of the negotiations.

Mr. F. L. Rawson said he was not aware that there were any tubes in use in boilers. This company was not so much engaged in cheap work, such as boiler tubes, but more in the manufacture of larger things. He might say that he had a statement of the amount of copper likely to be used, by one of the officials of this company, and the figures were something enormous, a long way more than himself and the other members of the board thought was possible. A tube 12 inches in diameter, solid drawn, cost 3s. a pound to make, and they thought they would be able to make them for 2d. or 3d. a pound; so that there was no use their going into the manufacture of boiler tubes when there were numbers of articles which cost a great amount of money and could not be made except by the Elmore process.

Mr. Dickson asked what was being done with regard to steam pipes.

Mr. F. L. Rawson said it was very unfortunate that Mr. Elmore, the father of their managing directors, was ill, and unable to leave

his bed. He could, however, say that the large steam pipes had been fully tested by well-known firms in the copper trade, who all agreed as to the extraordinary quality of the copper. Several of them had told him that they had no idea it was possible to make copper of that quality at all. Not only did they intend to make the large pipes, but there was a large demand for copper platings, which were now made in large quantities, and that was one reason for changing their works, so as to be on the direct main line of the Midland Mailway.

Mr. Stepney Rawson said he had great pleasure in giving them a short account of the results of the trials which were made abroad, and at which it was his good fortune to have assisted. Some months ago, before the company was brought out, he had certain figures brought before him as the result of previous trials made by Mr. Elmore and his sons. On examining them he was unable to find any flaw, but his verdict was they were too good to be true. When it became his business to go and examine into these trials he went to pick holes in the process, if he could find any, but he was as unable to find any holes in the process as he was to find fault with the previous figures. He also made it his business to examine into the statements made in the prospectus, and with regard to these, he might say they had been thoroughly borne out, with a very large margin to spare. There was a statement made at the commencement of the prospectus—which looked like one of the ordinary rhetorical flourishes one often saw—that there was an analogy between this process and the well-known Bessemer steel process. His personal experience, gathered from a more intimate knowledge than anyone other than the inventors had, was that that was strictly true. Now that the Bessemer process was thoroughly well known, it was a matter of history. The history of the Elmore process had yet to be written, and he thought it would be written in letters of gold. At the trials it worked without a hitch from start to finish. The more complete trial extended over 10 days. They were working night and day, and a great part of the time he was actually present, till the simplicity of the process began at last to pall upon one. There was absolutely nothing to do except to keep the engine going; the rest of it was purely automatic, and became rather wearisome from its absolute simplicity. The keynote was, no doubt, the burnishing. It seemed a small difference from doing a thing without rubbing, and doing it with rubbing; but that was the key to the whole process. Now, it might occur to some of them that he was speaking only as an electrician, and that would be perfectly justifiable; but he saw there many technical and practical authorities on copper working, who were as much astonished as he was: commencing with absolute doubt of the possible result of the statements, proceeding from that to incredulity, and at last winding up with confident belief. The proofs were on their own machines, attended by their own workmen; and there was no possible better proof than to see a practical man start with the idea that a certain thing could not be done, and then for him to find that he could do it himself. That he saw on many separate occasions, and from the more technical to the practical man, at the finish there remained nothing but one implicit belief in the value of the process. He heard statements made towards the finish of the trial that such a thing should be carried out on a very large scale, for the reasons that the results could not be produced by any other process; and even such results as might possibly be produced would cost so much to obtain that they would be out of competition with the Elmore process. It became necessary at the end of the tests to invent more stringent tests than ordinary copper was usually put to. These tests were invented by people who were looking into it, and many of them were proposed ironically. The results of these tests were absolutely successful, leaving over and above what they had proposed a very considerable margin, making it possible to put the copper to still further tests than they had ironically proposed. One test was submitted to a large meeting of the most capable authorities on copper in the world, and the next day it was carried out with the result that perhaps the greatest authority in the world expressed himself absolutely satisfied, and a thorough believer in the process. From the practical side of the question, there could be no doubt of the value of the process, and he could give them no better proof of his own conviction, than by saying that on his return to England he at once bought as many shares as he could afford, and advised his own personal friends to do the same to any extent.

The Chairman thought their very best thanks were due to Mr. Stepney Rawson for the information he had given them. The information was unsought by the board, and he did not know that Mr. Rawson would be there, or make any such report. It was a most interesting statement, and he thought they would agree that Mr. Rawson was entitled to their thanks.

A vote of thanks to the chairman closed the proceedings.

Woodhouse and Rawson, Limited.

AN extraordinary meeting of shareholders in Woodhouse and Rawson, Limited, was held last Friday at the Cannon Street Hotel, Sir John Stokes presiding.

The Secretary (Mr. J. Shurmer) having read the notice convening the meeting, the report, which was published in our last issue, was taken as read.

The Chairman then said: I have much pleasure in meeting you again, and in being able to put before you not only very satisfactory results, but also good prospects for the future. With regard to the general business of the company, the advance in electrical work that I mentioned at the meeting in December last is continued, and during the last few months there has been a great extension of electrical enterprise in all directions. Our business is steadily progressing, and we are glad to say that with regard to our installations, the really good work which we do is fully appreciated. When we consider the large amount of central station work that has been done, not only in London (where there are 21 central stations), but in other parts of England and the Continent, the outlook is very encouraging. With regard to the contracts on hand for the maintenance of installations, owing to the good quality of the work done and materials supplied, we find the maintenance is costing less than we originally anticipated. Our general business has steadily increased outside of electrical work, and we have taken out and acquired several valuable patents, chiefly electrical, during the past year. Abroad, there has been a rapid and growing increase in our business, and I am happy to announce that we have satisfactorily carried through an important negotiation whereby we make a large profit, and we have also made arrangements whereby we secure the supply of considerable quantities of the various goods required by several leading electrical companies. With regard to the Elmore patents, in which we are interested, the Elmore Patent Copper Depositing Company, which I mentioned at the last meeting, has been successfully brought out, the shares being subscribed for nearly four times over. Since then we have put up a plant abroad, and have amply proved the statements that we made as to the value of the process. The trials were witnessed by some of the most experienced men in the copper industry, and they were thoroughly satisfied on every point. I myself saw some articles being made, and the experiments going on, and these were indeed a great surprise to the technical men, on account of the extraordinary results and the very high quality of the copper, they acknowledging the low cost of manufacture, the high quality of the articles made, and the other advantages of the system. I may mention that the workman employed actually refused at first to make the experiments with the copper as requested, being, as he said, certain of failure; but they proved perfectly successful; in fact, it is now undoubted that this is one of the most important of recent discoveries, and it is very gratifying to this company to have been concerned in it in such a way. With regard to the amalgamation and sale to the new company; this is on the lines approved at the last meeting: that you now receive your dividends up to June 30th last, together with a bonus of 10 per cent. on the amount paid up on your shares from the new company; and, besides this, certain assets are to be distributed amongst you. It is expected that these will amount to a substantial bonus, and that as the new company takes over the business at fixed dates as going concerns, it will be able to pay a considerable interim dividend in July next. The directors have not taken this step without mature deliberation, and as they themselves hold more than one-tenth of the whole capital of this company, it is in the interests of the shareholders. I may say that the new company will be a strong, compact organisation, with a first-rate board and the same supervision and staff that we have now, together with the advantages of the staff from the other companies. Its constitution will be an amalgamation of manufacturing, supply, and installation interests, and it will be capable of undertaking not only almost every description of electrical work, but the larger contracts that are expected. As you are aware, at present the major portion of the profits, after paying 10 per cent., goes to the holders of the founders' shares. By the sale to the new company, these shares are done away with, thus enabling us to pay larger dividends than before. The dividend now declared makes 12 per cent. for the year. Satisfactory as this is, I may say that from the earnings made by the companies to be amalgamated, the new company will be able to pay in July next a still higher rate, and we anticipate a considerable demand for the shares, which will be issued almost immediately. The chairman then formally moved the adoption of the report and accounts.

Mr. Lambert seconded the motion.

Mr. Fellowes asked as from what time the new company would take over the present company's business, supposing the agreement were ratified?

The Chairman: From January 1st of this year.

Mr. Fellowes: The dividend now proposed takes us up to June 30th last. What represents the dividend between then and now?

The Chairman: The bonus you have received.

The adoption of the report and accounts was then carried *nem. con.*

The Chairman moved a resolution in the following terms, approving the agreement to be entered into for the purposes of amalgamation: "That the agreement, a draft of which has been produced to this meeting and initialled by the secretary, is hereby approved, and the directors are hereby authorised to enter into the same and carry the same into effect."

Mr. F. L. Rawson said the agreement was as between Woodhouse and Rawson, Limited, and the new company. The first clause stated that the vendor company should sell and the purchasing company should buy as from January 1st, all the property of the old company (Woodhouse and Rawson), with the exception of the interest of Woodhouse and Rawson in certain assets which were going to be distributed amongst the shareholders, and also with the exception of the book debts due to and from the vendor company. The object was that the new company should take over the businesses with a perfectly clean sheet. The consideration would be the sum of £200,500, including £38,500 in ordinary, £3,000 in preference, and £20,000 in debenture shares. The result was that the shareholders in Woodhouse and Rawson would have to take a certain amount of cash; and that would be arranged for afterwards by the liquidator. Other clauses in the

agreement provided that the shares in the new company should be fully paid up; that the new company should take up all contracts pending, and indemnify the old company in respect of them, that the new company should take the title of the old company, without inquiry or investigation; and that the old company should take all necessary steps to give effect to the agreement. Annexed to the agreement was a schedule of the property to be taken over.

Mr. Reed said it had been stated at the last meeting that shareholders would not be expected to take shares in the new company, but receive, if they wished, the full amount of their shares in Woodhouse and Rawson. He wished to know if this were confirmed.

The Chairman: It will be so if the company is satisfactorily launched.

Mr. Rawson: No doubt that will be so if the company is floated. The present arrangement is that we get a large amount of cash quite sufficient to pay out all the shareholders who want to be paid out.

Mr. Brown (solicitor): That is the right of every shareholder under the Act.

Colonel Patten then seconded the motion, which was carried unanimously, and the meeting terminated,

The Edison Continental Company.

THE following is the report read at the ordinary general meeting of the above company:—

Gentlemen,—We have the honour of rendering you an account of our operations during the year 1888. That year was signalised by an incontestable progress in the electrical industry generally. You know, in effect, that the Paris Municipal Council has authorised the lighting of the capital by electricity by means of underground canalisations. This decision, the consequences of which are of considerable importance, gives a special importance to our undertaking. We had, nevertheless, for some time foreseen it, and it was in the certitude that the canalisation of Paris by electric cables would, after a very short interval, impose itself upon the municipal administration, that we last year acquired the electric station of the Cité Bergère; we wished really to be the first to profit by the general authorisation which we expected one day or the other to see given by a competent authority; we wished to have a works already installed, a basis for more extended operations which are certain to be realised. It was on this account that, at the beginning of the year, we obtained, by virtue of the general decision of which we speak above, from the municipality the concession for a part of the canalisation of the City of Paris, which has for its base the line of the Grand Boulevards, from the Faubourg St. Denis to the Grand Hôtel. In addition to the private lighting which is conceded to us, we have entered into a treaty by which the city has reserved to itself the right of giving a period of ten years for the lighting of this portion of the Boulevards by means of arc lamps during the whole duration of the Exhibition. The works are begun, and it is, as we have said, our central station of the Cité Bergère which will furnish the electric current for this lighting. This station, which formerly supplied 1,000 lamps, now supplies about 4,000, and the portion of our section which we intend to light this year already assures, by treaty, the working of 15,000 incandescent lamps. We have also finished the station which we had begun in the Cour d'Honneur of the Palais Royal, which allows of our joining the working of the Comédié Française and the Palais Royal Théâtre to the lighting of the various shops and galleries; this station began work at the commencement of the year. This undertaking has been conceded to our company by the Minister of Public Instruction and Fine Arts, by treaty dated August 12th, 1887, a treaty which, on account of difficulties of a purely administrative order, only became capable of application after a modifying convention which came into operation on May 11th, 1888, the time at which we began the work. Since putting it in working order, though this is of so recent a date, this central station has very much extended, the number of lamps supplied being 4,368. These two stations of which we have spoken, and which did not enter into the period of profitable working till after January 1st, 1889, have necessitated the employment of a large capital, which, during the last financial period, has been unproductive. This explains the smallness of the dividend which we propose to distribute to you; but the simple examination of our position will show you that there is every reason to regard the future of our company with confidence. The lighting which we have undertaken in the different theatres of Paris, notably that of the Opera, have given the results which we expected. The *matériel* of our manufacture is as much appreciated as in the past, and, in the competition opened by the City of Paris for its electrical station at the Halles Centrales, our company obtained the contract for supplying the materials and continuous current machines. We may tell you also that abroad our *matériel* is as much appreciated as in France, and it was on this account that we obtained at the Barcelona Exhibition a grand medal of honour *hors concours*. We are in hopes that electric lighting and the transport of power will extend greatly in France, thanks to the Exhibition, at which we shall take a large part, and that our works will profit from it by the importance of the orders which it will receive. As you know, gentlemen, we have ceded our patents for the manufacture of lamps to the General Company of Incandescent Lamps. That company gave us in the first half-year of its existence an interest of 6 per cent. per year, at the same time putting by a large reserve. There is occasion to hope that this result, already very satisfactory, will be still better as soon as the new works which the company is now engaged on are finished. Taken generally, the working for the year 1888 presents a profit of 262,066 francs, which we propose to divide as follows:—5 per cent. to the legal reserve, 13,103 francs; 4 per cent. interest on the shares, *pro rata temporis*, or at the rate of 20 francs for the 7,000 old shares, 140,000 francs; and at the rate of 12 francs 91 cents for the 7,000 new shares, 90,416 francs; total 243,519 francs, and to report 18,546 francs to the profit and loss account for 1889. Again, after a distribution of 42,000 francs, at the rate of 3 francs per share, on the 14,000 founders' shares of your company, there remains a balance of 8,545 francs, which we beg you to authorise us to distribute at the rate of 0·61038 per share.

BALANCE SHEET TO DECEMBER, 31st, 1888.

Active.

	F.	C.	F.	C.
Shareholders, payments remaining to be made ...			6,875	0
Banks and cash			734,033	0
Debtors' accounts			829,901	25
Effects to receive			168,670	45
Shares and obligations in portfolio			650,055	0
Deposits and securities			11,942	45
Works and furnitures invoiced			63,302	0
Participation in the Société Civile de l'Usine d'Ivry			230,115	71
Land at Brünn			9,611	10
Real Estate of Ivry, new buildings, and material, and industrial utensils of the factory	1,471,890	49		
Amortisation, 1888	47,407	05		
			753,753	44
Various supplies, products manufactured and in course of manufacture			1,534,391	43
Installation in the Administration ...	1,471,899	35		
Amortisation, 1888	100,000	0		
			1,371,899	35
Central stations of electricity—Paris			1,401,451	69
Rents paid in advance			35,933	30
Expenses of installation	27,205	70		
Amortisation, 1888	5,188	0		
			22,017	70
Office furniture	8,761	60		
Amortisation, 1888	1,094	60		
			7,667	0
Taxation held from shareholders ...			16,418	25
			7,848,038	12

Passive.

	F.	C.
Capital	7,000,000	0
Amortisation funds from capital	11,342	70
Legal reserve	18,487	43
Special reserve	65,775	75
Dividend, 1887, remaining to pay	6,550	15
Due to founders' shares	50,545	40
Creditors' accounts	433,270	54
Balance of profit and loss accounts	266,066	15
	7,848,038	12

The Consolidated Telephone Construction and Maintenance Company, Limited.

IN the report to be presented at the eighth annual general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, in the City of London, on Thursday, May 30th, 1889, at 12 o'clock noon, the directors have pleasure in submitting to the shareholders the accounts of the operations of the company for the year ending the 31st March, 1889, showing a nett profit of £11,914 4s. 3d., which, with the amount carried forward from last year, leaves a balance of £13,286 14s. 2d. for disposal, after making provision for doubtful debts.

The directors propose to deal with this amount as follows, viz.: To pay a further dividend of £7 per cent. for the half year, making, with the interim dividend paid in November last, £6 per cent. for the year; writing off the sum of £520 4s. 6d. for depreciation of plant, machinery, and furniture, and the sum of £2,000 from goodwill, patent rights, &c., thus leaving a balance of £1,558 17s. 7d. to carry forward.

During the year the directors have received a further sum of £3,044 18s. 6d. on account of profit arising from the liquidation of the River Plate business, which is included in the above statement, and there is still a balance to be received under that head.

The action in Belgium in relation to the patents, in which the Edison Gower-Bell Telephone Company of Europe is interested, is now in the hands of experts, to decide whether the instruments used in Belgium are infringments of the Edison patent. It is difficult to see how they can decide otherwise, as the law courts of England and the United States have repeatedly decided that they are infringments.

The directors are pleased to state that the working of the factory under their direct management has proceeded very satisfactorily, with the results as shown in the balance sheet.

The relations between the United Telephone Company and this company continue to be of an amicable nature, and the board are glad to report that increased orders have been received during the past year from the managing director of that company.

The subsidiary companies continue to make most satisfactory progress, as is shown by the following statement:—

YEAR ENDING 31ST MARCH.

	Subscribers.		Rental.		Increase.	
	1888.	1889.	1888.	1889.	Subs.	Rental.
Telephone Co. of Austria	2,036	2,441	£13,483	£15,588	405	£2,105
Anglo-Portuguese Telephone Co...	1,500	1,713	£9,772	£11,077	213	£1,305
	Total increase for the year ...				618	£3,410

For some time the board have had under consideration the necessity of finding working capital for the subsidiary companies. With this object in view it will be seen that notice is now given for taking the necessary legal steps to carry out this proposal, and the attention of the shareholders is called to the prospectus which refers to an issue by the Consolidated Telephone Construction, &c., Company, to its shareholders of 15,000 £1 preference shares to bear interest at the rate of £6 per cent. per annum with a preferential right to return of capital.

In accordance with the articles of association the following directors retire by rotation, and being eligible, offer themselves for re-election, viz. :—J. H. Buckingham, Esq., and Richard Van Zeller, Esq.

The auditors, J. G. Griffiths, Esq., F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.), and A. E. Green, Esq., F.S.A.A., also retire, and offer themselves for re-election.

United Telephone Company.—The directors, at their meeting on Thursday, decided, subject to audit, to recommend at the forthcoming general meeting, to be held on the 29th inst., a dividend for the second half-year ending April 30th, 1889, at the rate of 12s. 6d. per fully paid share, less income tax, making, with the interim dividend paid on December 7th last, a total dividend for the 12 months ending April 30th last of 17½ per cent. on the paid-up capital of the company. The transfer books will be closed from the 20th to the 29th inst., both days inclusive.

The Sheffield Telephone Exchange and Electric Light Company, Limited.—The first annual meeting of shareholders was held at the offices of the company in Commercial Street, on Thursday, May 16th, at noon. A satisfactory report was presented to the shareholders, of whom there was a good attendance, and a dividend of 7½ per cent., free of income tax, was declared, in addition to the sum of £793 which was carried to a reserve fund.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the weeks ended 3rd and 10th May amounted to £2,844 and £3,086 respectively; 17th May, £4,032.

The Western and Brazilian Telegraph Company, Limited. The receipts for the weeks ending 17th May, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,544.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th May are £3,141, as compared with £2,852 in the corresponding period of 1888.

ELECTRIC LIGHTING IN WESTMINSTER.

MR. A. H. HAGGIS, the chairman of the Highways' Committee of the London County Council, at the weekly meeting on Tuesday last, submitted the report of the committee, who reported that they had considered a notice by Messrs. L. Clark, Muirhead and Co., Limited, that, in pursuance of powers conferred on the St. James and Pall Mall Electric Light Company, Limited, under license granted by the Board of Trade, they proposed to lay electric light mains and distributing boxes under certain thoroughfares in the parish of St. James, Westminster, viz. :—Piccadilly, Piccadilly Circus, Regent Street, St. James's Square, Pall Mall, St. James's Street, King Street, and Duke Street. The Vestry of St. James had already consented to the laying of the mains referred to in the notices, and the committee recommended :—"That the consent of the Council be given to the laying of the St. James and Pall Mall Electric Light Company's mains and distributing boxes in the above-named streets, on condition that the work be carried out to the satisfaction of the proper authorities."

A COUNCILLOR asked what steps the Council had taken to prevent a monopoly and to see that the work was satisfactorily done?

Mr. HAGGIS replied that the local authorities in the districts through which the mains would go had the right to make suggestions for that purpose, and to require alterations if they thought desirable as to the way the mains were placed.

The COUNCILLOR urged that there should be some provision so as to prevent the roads being unnecessarily disturbed and obstructed, and he moved that the matter be referred back to the committee.

Mr. JOHN LLOYD seconded the amendment, and said that now that the Council were asked to give their consent to the laying of electric lighting mains they ought to do something to cause their consent to be given on somewhat the same conditions as those laid down in Major Marindin's report for the whole of the Metropolis. If they had that power they ought to exercise it. They ought to act in the light on the subject which their present knowledge gave them. The matter ought to be considered in connection with the important report just issued of Major Marindin. He (Mr. Lloyd) therefore seconded the proposal that the question be referred back to the committee.

Mr. HAGGIS stated that the whole question of the electric lighting of London was before the Highways' Committee. But the case now under the consideration of the Council was one in which licenses had already been granted by the Board of Trade last year. The company obtained the right last year to lay the mains, and they now proposed to put those rights in force. Other companies had applied for rights, but had not yet got them. The whole of them would come under the consideration of the Highways' Committee.

The amendment was carried.

PORTSMOUTH AND THE ELECTRIC LIGHT.

A NEW movement has now been started, with the view of introducing the electric light into the Borough of Portsmouth under far more favourable auspices than have hitherto been possible. As a result of the recent deputation to Brighton and Eastbourne, a private meeting was held at the George Hotel, Portsmouth, on Monday afternoon, under the presidency of the Clerk of the Peace (Mr. R. W. Ford). There was an influential attendance, comprising the Mayor (Mr. G. Ellis), Colonel Mumby (Chairman of the Alverstoke Local Board), Colonel Lanyon Owen, J.P., Major Lawrence Gordon, and Messrs. W. Edmonds, J.P., A. W. White, A. R. Holbrook (*Portsmouth Times and Evening Mail*), C. E. R. Isherwood, W. Payne, L. G. Bonham Carter, E. Hide (President of the Chamber of Commerce), T. Bailey, A. H. Ford, C.E., T. Scott Foster, J. Read. jun., H. Vosper, J. McKinlay, D. M. Ford, &c.

The CHAIRMAN observed that it was felt that the time had now arrived when the question of electric lighting should be dealt with in the Borough of Portsmouth in the same manner as it had been dealt with by other large towns. He pointed out that at Brighton, Eastbourne, Kensington, and elsewhere successful installations had been established, and he had now before him an offer on behalf of the House-to-House Electric Supply Association to establish at Portsmouth a station for supplying the light throughout the Borough. The company did not come into the town as beggars; on the contrary, they were willing to find themselves, if necessary, £50,000, which was the whole of the capital required. They were, however, desirous that the control of the projected enterprise should be to some extent, at any rate, in local hands, and they would, therefore, afford local capitalists an opportunity of taking shares in the undertaking.

Colonel OWEN having afforded the meeting some details with reference to the recent deputation,

Mr. BINGHAM, representing the promoters of the scheme, entered into the system which it was proposed to introduce, and claimed that electric lighting had now passed out of its experimental stage, and was of great practical utility. It was often claimed that America took the lead of the whole world in matters of electric lighting; but, so far as underground mains were concerned, Eastbourne led the universe. Treating an 8 C.P. incandescent lamp as equal to an ordinary gas lamp, electric lighting could be effected at a rate equal to about 2s. 7d. per 1,000 cubic feet of gas.

A discussion followed, and the opinion of the meeting was unquestionably strongly in favour of the local introduction of the light, though some speakers thought that the Corporation ought to take the initiative. At the close of the meeting, however, it was definitely stated that a company would be started with a capital of £50,000, of which only one half would now be called up, as the estimate for laying down the necessary plant and mains would be more than covered by that amount.

ELECTRIC LIGHTING AT BATH.

A CIRCULAR has been issued by the chairman of the Bath Electric Lighting Company, Major-General Burn, in the course of which he announces that unless at least £10,000 additional capital is applied for before the 27th inst., they will not feel justified in adopting the provisional contracts which would enable them to lay down the electric light for private lighting. The public lighting is, of course (adds the chairman), already assured, but in view of the desire which has been generally expressed to have the means for private or internal lighting, it is hoped that the citizens generally will recognise the necessity of subscribing at once to an undertaking which will supply the want. The directors are able, from reliable data at their disposal, to assure both investors and consumers that the light can be supplied at such a reasonable scale of charges as would bring it within the means of all classes, and at the same time allow of remunerative dividends to shareholders. It would, therefore, be a matter of deep regret to the promoters if the undertaking—conceived in a public spirit, and with a desire that the city should not be behind less important towns—should fall through for lack of public support.

THE STRENGTH OF THE INDUCED CURRENT WITH A MAGNETO TELEPHONE TRANSMITTER AS INFLUENCED BY THE STRENGTH OF THE MAGNET.*

By CHARLES R. CROSS and ARTHUR S. WILLIAMS.

IT is a well-known fact in practice, as well as an evident consequence of theoretical considerations, that the effectiveness of a magneto telephone when used either as a transmitter or as a receiver varies with the strength of the magnetism of the core. But the relation of the one to the other has never been studied, so far as we are aware.

Our investigations include a study of the changes in strength of the current produced by a magneto transmitter under varying conditions of magnetisation, and of the magnitude of the momentary changes in the magnetic condition of the core of the receiving telephone when subjected to the action of undulatory or other brief currents, as influenced by the strength of the primitive permanent magnetisation of the core. The present paper contains only the results of a series of experiments relating to the first of these, that is, to the effect of varying strength in the magnet of the transmitter, the study of the allied problem of the receiver being still in progress.

The apparatus employed consisted of a cylindrical bar of soft iron about $4\frac{1}{2}$ inches in length and $\frac{1}{4}$ of an inch in diameter, around one end of which was placed a coil of fine wire similar to that used in ordinary telephonic practice. The resistance of this coil was 100 ohms. It was placed in circuit with a ballistic mirror galvanometer, from whose deflection the momentary current produced in the coil by any variation in the strength of the core could be determined. The diaphragm, which was in all cases $2\frac{5}{16}$ inches in diameter, was in its usual place opposite the end of the magnet about which the wire coil was wound, and about $\frac{3}{100}$ of an inch from that end. By means of a rod carrying a cam moved by a weight, a rapid inward push of definite amount was given to the diaphragm, thereby inducing a current in the coil already referred to, and so deflecting the needle of the ballistic galvanometer. The soft iron bar was also surrounded by a second helix, through which was passed a current from a storage battery, serving to magnetise the core. A tangent galvanometer inserted in this circuit gave the strength of the magnetising current. A magnetometer placed in the prolongation of the axis of the core, which last occupied an east and west position, made known the relative strengths of the field produced by the core under different conditions of magnetisation.

Corresponding observations of the magnetometer reading, and of the current induced when the diaphragm was moved by the cam, were made throughout a widely varying range of strength of field, and the results were represented graphically by constructing a series of curves in which ordinates represent the relative strength of field, and abscissæ the current due to a given predetermined throw of the diaphragm (about $\frac{1}{100}$ of an inch), as ascertained from the readings of the ballistic galvanometer.

One of these curves is shown at 1, fig. 1, the core in this case being a cylindrical bar of Norway iron $4\frac{1}{2}$ inches long and $\frac{1}{4}$ of an inch in diameter, and the diaphragm an ordinary disc of ferrotype iron $2\frac{5}{16}$ inches in diameter and $\frac{1}{100}$ of an inch thick (No. 31 B.W.G.).

Table I. gives the data from which fig. 1 was constructed. The strength of field is given in terms of the tangents of the angles of deflection of the magnetometer needle. The induced current is given in arbitrary units, as only relative values are needed. A determination of the value of the deflections was made by observing the excursion due to the discharge of a condenser through the ballistic galvanometer, and it was found that the abscissa 100 on the curves corresponds to a sudden discharge of approximately 0·00000097 of a coulomb through the coils of the galvanometer.

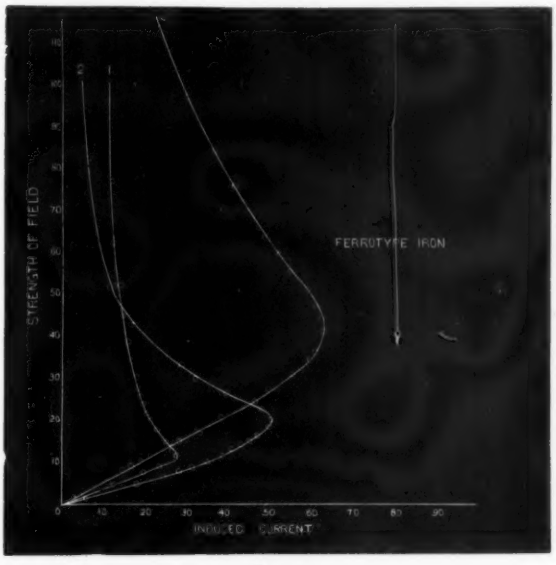


FIG. 1.

TABLE I.

CORE, NORWAY IRON.

Diaphragm, Disc of Ferrotype Iron, No. 31.

Strength of field.	Induced current.	Strength of field.	Induced current.
...	0·7	·211	20·5
·016	3·3	·229	19·8
·044	12·0	·248	19·2
·058	19·3	·270	18·7
·089	23·3	·302	18·0
·118	27·0	·342	16·9
·141	26·8	·390	16·1
·132	26·6	·454	14·7
·146	25·3	·530	13·3
·164	23·8	·625	12·7
·182	22·5	·773	12·0
·196	21·6	1·014	11·5

TABLE II.

CORE, BESSEMER STEEL.

Diaphragm, Disc of Ferrotype Iron, No. 31.

Strength of field.	Induced current.	Strength of field.	Induced current.
·005	2·0	·279	17·8
·030	7·7	·333	16·7
·082	20·7	·396	15·0
·137	26·7	·507	13·5
·160	24·8	·625	11·7
·191	21·2	·748	10·8
·213	19·3	·907	9·7
·248	18·6	1·099	8·7

Cores of Bessemer steel and of untempered soft steel were also used, with results given in Tables II. and III.

TABLE III.

CORE, UNTEMPERED SOFT STEEL.

Diaphragm, Disc of Ferrotype Iron, No. 31.

Strength of field.	Induced current.	Strength of field.	Induced current.
·031	8·2	·275	18·0
·049	12·0	·321	16·5
·089	22·0	·388	15·2
·137	25·9	·473	13·8
·157	24·9	·618	12·7
·171	22·9	·776	11·0
·194	21·1	1·011	9·5
·216	19·7		

TABLE IV.

CORE, NORWAY IRON.

Diaphragm, Two superposed Discs of Ferrotype Iron, No. 31.

Strength of field	Induced current.	Strength of field.	Induced current.
·016	5·0	·184	49·3
·054	19·3	·205	50·2
·070	25·7	·229	48·0
·081	28·5	·266	40·3
·089	30·2	·306	31·8
103	35·0	·342	27·7
·119	38·5	·433	16·7
·133	40·7	·530	11·9
·144	42·7	·667	8·3
·155	45·7	·830	7·0
·169	47·0	1·018	5·0

An examination of fig. 1, as well as of the various curves following it, will show that the effect of increasing the strength of the magnet of the transmitter is in all cases to cause at first a rather rapid increase of the strength of the induced current, which later increases less rapidly, rising soon to maximum value, from which it falls off, at first rapidly, and afterwards more and more slowly as the strength of the field is further increased. We proceed to consider the explanation of these results.

It is evident that three distinct sources of variation exist to affect the current furnished by a magneto transmitter as the strength of the magnet is increased. First, the direct effect of the increased strength of field

* Proceedings of the American Academy of Arts and Sciences.

in which the diaphragm moves is to increase proportionally the strength of the induced current, since it increases correspondingly the rate of change in the number of lines of force enclosed by the coil of the instrument; second, an approach toward saturation of the magnet, so far as it alone is concerned, will tend to diminish the induced current, on account of the smaller variation in the strength of the pole due to a given motion of the diaphragm; and, third, the nearer approach toward saturation of the diaphragm will have the same tendency.

The rapid rise in the induced current at the beginning is of course due to the predominating influence of the increasing strength of the field in which the diaphragm moves, as both core and diaphragm are then but slightly magnetised. The subsequent changes in the current must be explained by a consideration of the increasing magnetisation of either the core or the diaphragm, or both.

It will be seen by comparing Tables I., II., and III., that the value of the maximum induced current for a given excursion of the diaphragm is approximately the same with all the three cores used, and that the same is true as to the strength of field corresponding to this maximum current. Moreover, saturation curves constructed for the several cores showed that in all cases the magnet was still very far removed even from half saturation when the maximum induced current was obtained. From these facts it appears that the degree of saturation of the magnet is practically unimportant, so far as the general results shown in fig. 1 are concerned.

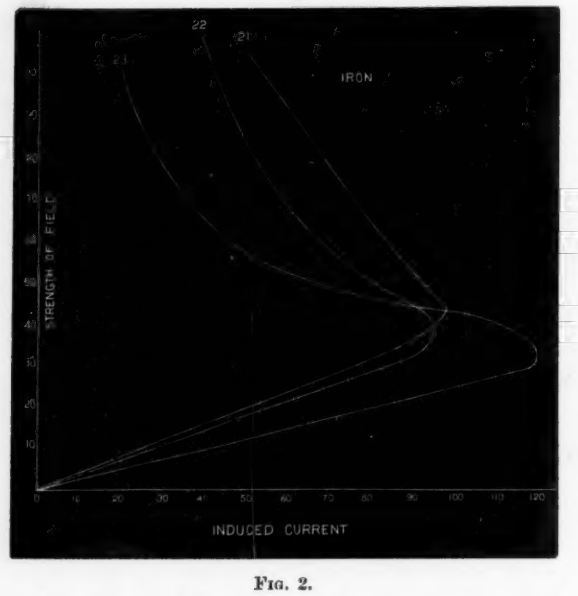


FIG. 2.

It remains to observe the part played by the increasing magnetisation of the diaphragm. Other things remaining the same, as this approaches more and more closely towards saturation the increase in the number of lines of force passing between it and the magnet on the approach of the diaphragm to the magnet must become smaller and smaller, and this change will tend to oppose the effect of the increased absolute strength of the magnetising force. The small mass of the diaphragm will evidently cause it to show the effect of an approach to saturation while the core is far below that condition. And such an action will clearly explain the observed changes in the current strength.

In order to test this matter still further, the experiment was tried of varying the mass and material of the diaphragm.

The results are shown by the curves in figs. 1, 2, and 3, which are constructed from the data given in Tables I. to X.; further results of the same character are given in Tables XI. and XII.

TABLE V.

CORE, NORWAY IRON.

Diaphragm, Three superposed Discs of Ferrotype Iron, No. 31.

Strength of field.	Induced current.	Strength of field.	Induced current.
·000	0·5	·346	59·7
·018	3·2	·366	60·7
·047	8·0	·390	61·3
·079	14·2	·416	63·0
·084	14·7	·445	62·3
·096	17·0	·479	61·0
·110	19·7	·514	58 5
·118	21·8	·550	55·7
·135	25·5	·591	52·4
·151	28·3	·637	48·7
·175	33·0	·659	47·3
·213	39·0	·765	41·7
·249	46·3	·854	36·7
·277	49·8	·983	30·0
·313	55·3	1·180	22·8
·329	58·7		

TABLE VI.

CORE, NORWAY IRON.

Diaphragm, Sheet Iron, No. 21.

Strength of field.	Induced current.	Strength of field.	Induced current.
...	0·3	·456	96·7
·016	3·1	·477	94·0
·058	13·7	·499	92·5
·082	20·3	·521	90·5
·102	25·2	·536	88·3
·125	31·2	·573	86·7
·150	37·8	·584	84·0
·178	45·5	·637	81·0
·213	54·7	·675	76·7
·249	63·8	·724	72·3
·296	75·5	·784	69·3
·348	86·2	·851	65·6
·378	92·3	·949	57·3
·416	96·7	1·061	49·1
·437	97·8		

TABLE VII.

CORE, NORWAY IRON.

Diaphragm, Sheet Iron, No. 22.

Strength of field.	Induced current.	Strength of field.	Induced current.
...	1·7	·410	94·2
·018	4·7	·431	92·0
·047	11·7	·452	88·3
·075	19·7	·473	85·0
·088	22·3	·494	81·2
·100	26·0	·516	77·5
·123	32·5	·541	74·7
·146	39·5	·566	71·3
·171	48·2	·601	67·7
·194	54·2	·635	64·0
·218	61·3	·659	66·0
·240	66·9	·719	56·7
·262	73·2	·779	53·0
·292	81·3	·851	48·0
·313	87·7	·946	44·0
·342	92·7	1·072	39·3
·372	94·3	1·091	38·3

TABLE VIII.

CORE, NORWAY IRON.

Diaphragm, Sheet Iron, No. 23.

Strength of field.	Induced current.	Strength of field.	Induced current.
...	1·7	·272	109·3
·026	10·0	·289	113 8
·068	26·8	·310	119·3
·086	33·0	·339	118·6
·096	39·0	·382	114·1
·116	47·0	·420	102·9
·139	56·3	·458	82·2
·162	65·8	·499	68·7
·176	72·3	·529	57·6
·194	78·3	·582	48·0
·216	86·4	·652	39·9
·229	90·0	·751	30·8
·242	96·3	·904	23·7
·255	101·8	1·011	19·0

TABLE IX.

CORE, NORWAY IRON.

Diaphragm, Steel, No. 26, Untempered.

Strength of field.	Induced current.	Strength of field.	Induced current.
·004	7·7	·281	66·7
·019	11·5	·313	63·8
·054	20·5	·342	60·4
·095	32·2	·380	56·3
·105	34·5	·422	50·5
·128	42·0	·483	44·7
·153	48·3	·530	39·0
·178	55·7	·584	35·3
·200	60·3	·652	32·0
·227	64·3	·810	28·2
·236	67·0	1·043	24·3

TABLE X.

CORE, NORWAY IRON.

Diaphragm, Steel, No. 26, Tempered.

Strength of field.	Induced current.	Strength of field.	Induced current.
·002	7·8	·344	36·3
·019	10·4	·400	32·0
·068	18·5	·466	26·9
·096	23·8	·545	21·7
·128	30·3	·642	17·7
·151	32·4	·662	17·3
·180	37·0	·732	15·2
·214	40·2	·816	13·8
·246	40·0	·854	13·0
·272	39·5	1·025	10·0
·304	37·9		

TABLE XI.

CORE, NORWAY IRON.

Diaphragm, Steel, No. 22, Untempered.

Strength of field.	Induced current.	Strength of field.	Induced current.
·007	6·2	·272	36·7
·023	8·0	·302	34·8
·070	17·3	·340	33·0
·103	23·0	·392	29·7
·121	26·4	·458	26·3
·139	30·1	·538	23·2
·157	32·8	·566	23·0
·176	35·0	·647	21·7
·202	37·1	·773	19·8
·224	34·9	1·046	17·6
·246	37·0		

TABLE XII.

CORE, NORWAY IRON.

Diaphragm, Steel, No. 30, Tempered.

Strength of field.	Induced current.	Strength of field.	Induced current.
·007	6·2	·272	36·7
·023	8·0	·302	34·8
·070	17·3	·340	33·0
·103	23·0	·392	29·7
·121	26·4	·458	26 3
·139	30·1	·538	23·2
·157	32·8	·566	23·0
·176	35·0	·647	21·7
·202	37·1	·773	19·8
·224		1·046	17·6
·246	37·0		

TABLE XIII.

CORE, NORWAY IRON.

Diaphragm, Steel, No. 30, Untempered.

Strength of field.	Induced current.	Strength of field.	Induced current.	Strength of field.	Induced current.	Strength of field.	Induced current.
·005	5·2	·160	41·9	·331	31·2	·632	20·4
·031	11·7	·200	38·3	·376	28·9	·735	19·7
·082	24·2	·231	36·2	·437	26·0	·819	18·0
·103	29·7	·272	35·2	·512	23·3	·956	16·3
·130	37·7						

Curve 2, fig. 1, represents the results when two of the ordinary ferrotype diaphragms were superposed, forming a diaphragm of double thickness, and curve 3 of the same fig. shows the results when three such diaphragms were superposed. Each diaphragm was 0·01 of an inch thick. The curves of fig. 2, marked 21, 22, 23 respectively, show the results of similar experiments with diaghragms of sheet iron whose thickness was 0·030, 0·027, 0·024 of an inch respectively (Nos. 21, 22, 23, B.W.G). Figure 3 shows the results when a steel diaphragm 0·017 of an inch thick (No. 26) was used, the curve U being that for untempered steel, and T that for tempered steel. Steel diaphragms respectively 0·026 and 0·012 of an inch thick (Nos. 22 and 30) gave similar results, as will be seen from Tables XI., XII., and XIII.

An inspection of these curves shows immediately that the greater the strength of the field required to saturate the diaphragm, the greater is the strength of the field at which the maximum current occurs. Thus in fig. 1 the maximum current with Curve 1 corresponds to a strength of field of about 12 units of the scale used, while with the Curves 2 and 3 the corresponding strengths of field are 20 and 43 units respectively. Also in fig. 2 the maximum currents will be seen to correspond to greater strengths of field in proportion to the thickness of the diaphragm, and in fig. 3 similar, though less marked results, hold for tempered as compared with untempered steel of the same thickness.

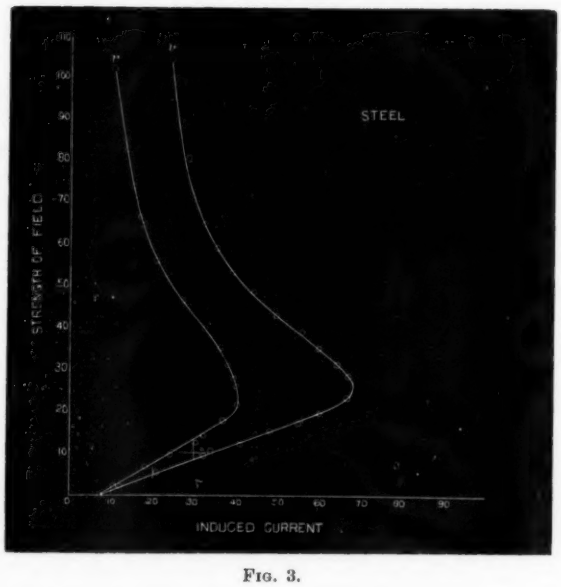


FIG. 3.

It would also be expected that the value of the maximum current would be greater with a thick than with a thin diaphragm. This was usually the case in our experiments. Thus the Curves 1, 2, 3, of fig. 1 give maximum currents of 27·5, 50·2 and 62·6 units respectively. Results of a similar nature are shown by fig. 3, the maximum current with the untempered diaphragm being far greater than with the tempered one. Curve No. 23 of fig. 2 is apparently an exception. It is probable, however, that this is in appearance only, and that the three curves of that figure are not strictly comparable with one another. The rigidity of the diaphragms here used, especially of the thicker ones, is considerable, and any slight yielding of the supports of the rod which carried the cam would prevent the actual throw of the diaphragm from being as great when this had considerable thickness, and would greatly diminish the strength of the current produced.

The peculiarity of Curve 2, as compared with 1 and 3, is probably caused by the want of magnetic and mechanical continuity in the material of the multiple plate formed by the several diaphragms used.

In those cases where steel diaphragms were employed, there was always a notable induced current, even when the reading of the magnetometer was zero. This was probably due to a slight residual magnetisation of the diaphragms.

The results stated in this paper may serve to explain a phenomenon which has seemed somewhat obscure. Frequent attempts have been made to increase the efficiency of a magneto transmitter by polarising the diaphragm as well as the magnet, a common way of doing this being to employ a horse-shoe magnet, one leg of which is in contact with the edge of the diaphragm, while the other, about which the coil is wound, is placed in its usual position opposite the centre. But as a general rule little or no gain has seemed to result therefrom, so far as can be judged by the performance of such instruments in actual practice. It is quite probable in this case that the increased approach to saturation of the diaphragm may have so great an effect as entirely to prevent the expected improvement.

It will also be seen from our results, that an increase in the thickness of the diaphragm of a magneto transmitter tends to allow of the use of a stronger magnet, and for a given amplitude of vibration to produce a stronger current. But it must be remembered, on the other hand, that the greater rigidity of the thick diaphragm will diminish this range of vibration under the action of the voice, a difficulty which may to a certain extent be remedied by using a diaphragm of large diameter.

Rogers Laboratory of Physics,
October, 1888.

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

ALL those who take an interest in the mode of action of lightning must feel they owe a debt of gratitude to Prof. Lodge for having awakened attention to lightning conductors by his two lectures delivered last year in connection with the bequest of the late Dr. Mann.

These lectures having been followed up by the discussion at the Bath meeting of the British Association, the lecture at the Royal Institution, and the paper lately discussed at the Institution of Electrical Engineers, it may be assumed that everything which our mathematical scientists can tell us at the present moment has now been said.

As a member of the Franklin-Faraday school, I attach infinitely more importance to the teachings of direct experiment than to any amount of deductions from theoretical reasoning, and consequently I feel myself to be somewhat out of court in criticising the conclusions arrived at by Prof. Lodge, although I have not yet found salvation in "Modern Views of Electricity." Nevertheless, I hope I may be permitted to break a lance in defence of the older theory.

The discussion which took place at Bath ought to become historical for more than one of the distinguished physicists referred to in the Dr. Mann lectures as scientific giants greater than Franklin, and greater even than Faraday, took part in it. This placing of Franklin and Faraday on pedestals lower than living men I think ought not to be allowed to pass without challenge.

I cannot help feeling it is to be regretted that an enthusiastic belief in the power of mathematics to solve the problems of Nature should have led to the speaking somewhat disparagingly of great men whose work in the near past has been of such incalculable value, and who have put the whole of the civilised world of the present generation under an almost priceless obligation.

Franklin and Faraday were scientists who gave rise to schools of thought; men whose knowledge was such that they must be regarded rather as thinkers in the language of electricity than as mere translators. They created the material out of which books have been written, and helped to build up mighty edifices, the

structure of which mathematicians have spent large portions of their lives simply in measuring.*

The treatment Franklin received at the hands of the Royal Society is a matter of history, and I fear it must be confessed that our scientific cults have not changed their nature in any very great degree since the period when Franklin lived.

Forty years ago the electricians of this country could be counted on the fingers of one hand. They were almost necessarily electricians by natural selection; men of knowledge rather than learning, and none of them were primarily mathematicians; but, nowadays, every mathematician seems to consider himself an electrician.

At college he devotes the whole of his mental energy to the study of mathematics, and becomes learned in methods. As an afterthought he goes in for electricity, which Sir William Thomson tells him can be completely mastered in three months.

On the strength of his mathematical acquirements, he looks down upon those who have produced the chief instruments of research, as well as created the whole of the electrical industry of the world; and, true to his early training, he seems to regard the highest outcome of science to be that of measuring, multiplying the number of measuring instruments, and the coining of new terms.

Prof. Lodge tells us all discharge is virtually that of a Leyden jar. At the Royal Institution lecture I was pleased to hear him say the whole of electrical science was included in a Leyden jar discharge. In other words, Nature loves simplicity, the same laws which govern a molecule governing also a planet, or, as we read in our school days:—

> "That very law which moulds a tear
> And bids it trickle from its source,
> That law preserves the earth a sphere,
> And guides the planets in their course."

And so it is with electrical motion. We may be sure that the only difference between a lightning discharge and a current developed by a galvanic couple consists in the rate and duration of the motion.

Prof. Lodge, notwithstanding he has given utterance to the above general truths, would, nevertheless, seem to consider there are fundamental differences between lightning discharges. He tells us there are discharges whose paths are negotiated, and discharges whose paths are not negotiated, because there is no time for negotiation.

One feels instinctively there must be some error in such reasoning, and further explanation seems to be required beyond that which has been given to account for what is observed in the two experiments, viz., "steady strain" and "impulsive rush."

If we analyse the above experiments by the older and simpler theory of Faraday, and not by that elucidated in "Modern Views of Electricity," which Prof. Lodge admits himself to be "singularly complex." What is observed can, I think, be accounted for without assuming lightning discharges, in certain cases, obey two different laws.

Faraday tells us all statical charge is sustained by induction. Induction may be regarded as the backbone of the Faraday theory, and the word induction was constantly on the lips of our older electricians.

In "Modern Views of Electricity," the term induction has really no place. It is, indeed, mentioned in the Dr. Mann lectures, but not in any way as an explanation to account for internal sparking in buildings, and certain vagaries described in connection with lightning discharges, all of which are attributed to oscillations and the surging about of lightning.

In my article published last summer in this Journal, I ventured to suggest that possibly the part induction played had been overlooked, and that I thought it would account for some of the phenomena observed.

Prof. Lodge will admit, for he says so in "Modern Views," that we may regard ourselves as being in an ocean of electricity. A statical discharge through a conductor always reminds me of a fish swimming in the sea. Resistance is opposed by the cohesive force of the water to the motion of the fish, and force has to be expended to overcome such resistance; but as fast as the water is divided in front of the fish, it closes in again at the rear.

In the case both of the moving fish and electrical motion in a conductor the disturbance is entirely local, but a statical charge, although practically confined to the matter which divides the positively and negatively charged surfaces, involves theoretically a strain throughout the whole of the electrical ocean.

Faraday says induction and conduction are the same in principle and action, every body appearing to discharge in a greater or less degree, which makes them better or worse conductors, worse or better insulators.*

Induction, according to Faraday, is the condition antecedent to all conduction, and it may be considered to be a movement inside the molecules producing in them a strained condition, such strain being communicated from molecule to molecule throughout the whole mass. Conduction is the relief of such strain by the breaking down and reformation of the molecular organisation. We see conduction under two conditions, viz., through metallic conductors and electrolytic ones. In an electrolytic conductor such as water, whose elements consist of oxygen and hydrogen, we have evidence of the breaking down and reformation of the molecular organisation.

What is seen to actually occur in an electrolytic conductor indicates, in all probability, what takes place in a metallic one.†

Disruptive discharge, I think, should also be considered as conduction; the molecular organisation is broken down in the line of discharge similarly to that of an electrolytic conductor, but no reformation occurs as is the case both in electrolytic and metallic conductors.‡

Perhaps I ought to apologise for introducing such elementary matter to the readers of this journal, but Faraday's theory is so ancient that I think it is sometimes forgotten, and the minds of our learned men in these days are so filled up with the elaborate detail and the large accretion of scientific literature that they occasionally stumble where a school boy would find no difficulty.‡

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* The most important aspect of any phenomenon, from a mathematical point of view, is that of a measureable quantity. I shall therefore consider electrical phenomena chiefly with a view to their measurement.—Preface to "Electricity and Magnetism," by Clerk Maxwell.

* My father used to relate some experiments tried by himself. He charged specially constructed Leyden jars and whilst charged hermetically sealed them; these were tested 6 months, 12 months, and three years after they had been charged, if my memory is to be trusted, and the whole three of them were found to have retained their charge. The experiments above referred to would seem to indicate that flint glass, if not a perfect insulator, approaches very closely to one.

† The leads of the powerful Groves batteries used at the lectures delivered at the old Polytechnic Institution were observed by the late Dr. Bachoffner to become chrystalline and brittle; the same thing has been observed in old needle telegraph coils, but I am not aware whether the leads of dynamos have been observed to be affected.

‡ As an illustration of what has been stated above I cannot resist telling the following anecdote:—In 1866 I introduced needle telegraph instruments in which the magnetised tempered steel needles were replaced by soft iron ones rendered magnetic by permanent magnets outside the coils, and four years after their introduction they were adopted by the Postal Department, who took credit to themselves for the invention, which was described in one of the Postmaster-General's reports as the greatest improvement which had been made in needle telegraphs. No doubt they had honestly reinvented my undemagnetisable coils, and I only supplied them. A year or two later, when there were altogether between 9,000 and 10,000 of these coils doing duty, a single case occurred in which the permanent magnets were demagnetised by lightning, the coil itself being protected by one of my lightning bridges. This demagnetisation of the inducing magnets led to an official letter being sent to the engineers, superintendents, and inspectors throughout the Postal Telegraph Department requesting suggestions for some simple method of ascertaining whether the magnets had lost their magnetism. Suggestions in response to this official communication were sent in. None of the proposed methods were, however, considered to be quite satisfactory, and consequently they were sent on to me for

It should be remarked that the metal plates in Prof. Lodge's experiments cannot be considered to fairly represent clouds. Stretched damp canvas with damped cotton wool placed on the top would more nearly represent an actual cloud, and had Prof. Lodge constructed his clouds of damp canvas instead of metallic plates, the phenomena observed in the impulsive rush experiment would have been considerably modified.

The most favourable conditions for a statical discharge are a point and a metal plate of considerable surface. When a point forms one of the surfaces of a Leyden arrangement, as was pointed out in my published article of last year, the potential of the electricity accumulated on the point is greater than that on the plate inversely as its surface is smaller, and therefore the potential of a point under such conditions approaches to infinity.

In the experiment of the "steady strain" the upper plate is an extension of the interior surface of the Leyden jar, and has the same electrical potential. The pointed and other conductors connected to the exterior of the Leyden jar form the opposite surface, and the potential of the charge on these conductors, as pointed out above, is greater than that of the plate inversely, as their surface is smaller. The charge between the plate and these conductors is sustained by induction through the dielectric air, and this I take it is what Prof. Lodge means when he says the path is negotiated.

In the "impulsive rush" experiment induction occurs between the upper and lower plates, just in the same way as in the "steady strain" experiments.

For discharge to occur between the interior of the jar and the upper plate of the impulsive rush experiment, the positive electricity of the upper plate (assuming the discharge into it is a positive one) has to be driven out, and induction between it and the lower plate necessarily precedes this driving out or discharge between the upper and lower plates, and therefore the upper plate may be regarded as a stepping stone only, there being as much induction or negotiation theoretically as is the case with the steady strain experiment, but in the atmosphere there is always more or less conducting matter held in suspension, and where time is given, this conducting matter becomes arranged by inductive action, and forms a bridge for electrical discharge, and therefore in the steady strain experiment there is accidentally, but not theoretically, a greater negotiation than in the "impulsive rush" experiment.* Assuming for the reasons given that, for discharge to take place in the "impulsive rush" experiment the induction potential of the dielectric air has to be raised to a higher degree, what then occurs? The Wimshurst machine accommodates itself to the greater resistance opposed, and charges the Leyden jars to a correspondingly higher potential, and therefore the discharge is a heavier one in the ratio of the increased resistance of the path of discharge.

I proceed to describe an experiment closely related to Prof. Lodge's "Impulsive rush," and which was made 40 years ago, when I was a boy. At that period my late brother and myself constructed apparatus to repeat an experiment due to the late Mr. Isham Baggs.

We mounted horizontally six Leyden jars on glass tubes, 2 feet 6 inches long, and sealed at the upper ends. These tubes worked on wooden uprights and formed insulated movable joints.

These mounted Leyden jars were charged in the ordinary way with a frictional machine to as high a potential as our machine was capable of developing, and the construction of the apparatus was such that by pulling a string the charged jars could be suddenly arranged in series so that the potential was increased six times.

The room in which these experiments were tried was heated to a temperature of over 100° Fah. to ensure absolute dryness of the atmosphere, a most important essential when carrying out experiments with statical electricity, and the dryness of the atmosphere was indicated by two hygrometers.

Now, with the frictional machine at our command, when the six jars were charged and discharged in the ordinary way, the space of air through which the discharge would leap was about half an inch only, but when arranged in series we obtained thick heavy angular sparks which leaped through a space of air with certainty 16 inches, and at times 18 inches, the length through which discharge would occur being considerably affected by the simultaneousness with which the jars were connected in series.*

We also tried the effect of charging five jars only, and bringing them in series with the foremost jar which was uncharged, here we had the impulsive rush experiment, but not quite under precisely the same conditions as Prof. Lodge's.

The interior of our jars were charged positively, and the effect of bringing the five charged jars in series with the uncharged one was to drive a positive discharge out of its interior through a space of 5 inches of air, the interior of the jar being charged negatively as a consequence.

The discharge from the five jars arranged in series would probably have leapt through 10 to 12½ inches of air, and the reduction of the length of the discharge to 5 inches indicates the resistance of the glass of the uncharged jar to electric induction. When a discharge from an upper cloud strikes a lower one, and this lower one discharges to the earth, the only effect is to somewhat reduce the resistance of the path as a mass of damp cloud is a better conductor than air.

I proceed to attempt an explanation why a pointed conductor in the "impulsive rush" experiment was not more effective in bringing about discharge between the plates than a rounded knob.

In Prof. Lodge's experiment the induction was practically uniform throughout, no portion of the metal plates having a higher potential than the other to determine a path of discharge, and the point was practically shielded by the favourable condition which the surfaces of the plates afforded for induction, the electric potential being lowered directly as the extent of surface between which it occurred.

Under such circumstances the inductive or conductive resistance (for they really are the same thing) becomes a determining cause in a path of discharge.

If the air space separating the plates be increased, say, to 10 times that of the actual experiment, and conductors be erected on the lower plate sufficiently high to bring about discharge, then I venture to say a pointed conductor would be found to be more effective than ad rounded knob to determine discharge, and such arrangement would more truly represent what happens when a higher cloud strikes a lower one and discharge occurs to the earth.

Maintain the increased distance between the upper

perusal, and I was asked if I could assist. Some of the suggestions involved the use of differential galvanometers and resistance coils, and the inevitable mathematical formulæ as a matter of course. Now it so happened that when a school boy I had introduced magnetism into our school, and magnetising knives and steel pens became a rage with the boys. I felt very much disposed to reply that when we were at school we used to ascertain whether our knives were magnetic by trying whether they would attract iron, and that we tested the strength of this magnetism by the weight of iron they were capable of lifting. Reverence for the Postal Telegraph Department restrained me somewhat; but, nevertheless, it did not prevent me from making some simple practical suggestions, and I received a reply from an electrician, now a distinguished F.R.S., that my suggestions were perfect, and he further added he was quite at a loss to understand what they could all of them been about.

* Faraday observed that brush discharge occurred more readily through nitrogen than other gases, and with more difficulty through oxygen than any other gas. I, myself, have observed that discharge between platina wires sealed in a vacuous glass chamber from a battery of 500 volts does not occur immediately the circuit is closed. A certain time invariably elapses before discharge occurs. It may be, however, that a certain invisible amount passes, which heats the partially exhausted air, and makes it a better conductor.

* We jumped somewhat hastily to the conclusion, as a result of these experiments, that the breaking down power through air was as the square of the electrical potential. I have regretted since we did not determine this point more accurately by testing the length of discharge with two jars, three jars, four jars, &c., but we were chiefly anxious to produce long discharges at the time.

and lower plates, but increase their surfaces 10 times, the pointed conductor will become shielded as before. Still further increase their surfaces, say, ten million times, the potential will then become so lowered that it is conceivable actual metallic contact must be established between the upper and lower plates to effect discharge.* Prof. Lodge's impulsive rush experiment cannot therefore be regarded in any sense as a crucial experiment which will help to guide the lightning conductor industry. On the contrary, as I said in my published article of July, 1888, the lectures of Prof. Lodge had a tendency, in my opinion, to unsettle men's minds, by conveying an impression that lightning discharges do not obey definite laws as believed by Faraday and our older electricians, but act capriciously and irregularly.

The object I have in view is not, however, to criticise Prof. Lodge, whose deep learning and ability I think I appreciate; the purpose of this article is to break a lance in defence of Faraday's theory as opposed to that elucidated in "Modern Views of Electricity." Prof. Lodge says in his last paper, "Recent advances in electrical theory made it easy for me to see further into the matter than the far greater men of the past." I hope I shall be excused for saying I think recent advances in influence machines have not been without their influence.

In the continuation of this article I purpose saying a few words on influence machines, the highest type of which no one, I think, will dispute is the Wimshurst. I will only now say I think these machines have been speaking on their own account in some of the lightning conductor experiments, and what they have been saying and doing has not been thoroughly appreciated.

(*To be continued.*)

ELECTRIC LIGHT PROVISIONAL ORDERS.

MAJOR MARINDIN'S report to the Board of Trade in reference to the applications made under the Electric Lighting Acts of 1882 and 1888 for Provisional Orders and licences was issued on Saturday, together with the following covering letter from the Board of Trade to the chairman of the London County Council:—

Board of Trade (Railway Department),
London, S.W., *May 18th.*

My Lord,—I am directed by the Board of Trade to transmit to you the enclosed copies of Major Marindin's report made after his enquiry, held by direction of the Board of Trade, into the various applications for Provisional Orders and licences under the abovementioned Acts in respect of the metropolis, as well as into the subject matter of a Bill introduced into the House of Commons by the Metropolitan Electric Supply Company, Limited.

In forwarding copies of this report for the consideration of the County Council, I am to inform you that, subject to any observations that they may wish to offer, the Board of Trade propose to adopt the recommendations of the report with regard to the allocation of the various districts to the several companies.

A description of these areas will be found in the report, from which it will be seen that in the following districts only powers over the same area are proposed to be granted to more than one company, viz.:—

St. George's, Hanover Square;

A small portion of the parish of Lambeth to the north of Westminster Bridge Road;

A small portion of the parish of St. Martin's-in-the-Fields to the east of Northumberland Avenue and St. Martin's Lane.

The Board of Trade concur in the opinion expressed by Major Marindin that, looking to the fact that the supply of electricity on the alternating current and transference system cannot be made use of for motors, the competition of a system which can be made useful for motors is desirable, and that, consequently, where powers are granted within the same area to two companies, both those companies should not be those using alternating currents. This principle has been adopted in allocating the various districts, except in so far as regards a small portion of the parish of Lambeth to the north of Westminster Bridge Road, which has been allotted to the London Corporation and the Metropolitan Company, both of which propose to use alternating currents and transformers.

The latter company was the only one which proposed to take the whole of the parish, and they are in possession of a site for a generating station in the northern corner of the parish. The whole of the parish was, therefore, allotted to this company, but it was found necessary also to grant powers to the London Company over a portion of the parish, in order to give access to the districts allotted to it on the other side of the Thames.

A small portion of the parish of St. Martin's-in-the-Fields has been allotted to the same two companies; but in this instance the latter company possess a generating station in Whitehall Place, from which the supply is by a continuous current.

In two of the parishes allotted to the London Company—viz., Chelsea and St. James's, Westminster—powers to supply electricity have already been granted to other companies by provisional order and licence granted in the years 1886 and 1888 respectively. Both of these companies, however, use continuous currents.

In the present orders it is proposed to substitute for the provisions as regards Schedule A and Schedule B, hitherto usually adopted, a provision that the undertakers should be bound at once to lay down mains in certain streets to be scheduled, and that they should be compelled to lay mains in any other streets in the area on requisition by owners or occupiers.

With regard to the question of capital, I am to point out that, while the capital of the various companies would doubtless be wholly inadequate if the entire areas allotted to them required to be lighted at once, they possess, in the opinion of the Board of Trade, sufficient capital to provide for all the work they are likely to be called upon at present to perform.

As regards the *maximum* price chargeable, the Board of Trade, in the absence of any evidence that such a price would be excessive, propose to adopt the *maximum* of 8d. per Board of Trade unit. They think, however, that a clause should be inserted providing for a revision of the terms of charge at the end of seven years from the date of the order, and they propose that this clause shall be so drawn as to make it possible to adopt, as regards electrical lighting, the principle of the sliding scale of charge, which has been applied with advantage under the Gas Acts. It is impossible at present to foresee the initial price which it will at the end of that period be reasonable to prescribe; but, following the analogy of gas, and considering that the electric companies only have a certain tenure of 42 years, the Board of Trade are of opinion that a price arranged on the basis of a 10 per cent. dividend would not be unreasonable.

With a view to saving time, the Board of Trade are now going through all the objections raised to the clauses of the orders, and are preparing a model order, which, with the necessary variations for the varying circumstances of different districts, would be adopted for the whole of the applications, and that, as soon as this model order is in a sufficiently advanced stage, a copy will be forwarded to the County Council.

In conclusion, I am to state that, as time is of the utmost importance, the Board of Trade would be glad to be favoured with the observations of the London County Council at their earliest possible convenience.

I have the honour to be, my lord,
Your lordship's obedient servant,
HENRY G. CALCRAFT.

The Earl of Roseberry, London County Council, Spring Gardens.

The following are the conclusions and recommendations of Major Marindin:—

After a careful consideration of the above points, and of all the evidence and arguments put before me, I have arrived at the following general conclusions:—

(1) That it must be admitted that the science of electric lighting has now reached the point at which a supply can be made which will be of very great benefit to the public, and that the power of obtaining this supply should be within the reach of all persons who may require it. For this reason it seems to me that although the wishes and opinions of the local authorities in the areas proposed to be supplied should be consulted and deferred to as far as possible, the mere objection by a local authority to the introduction of a company proposing to supply electric light upon general grounds should not be considered sufficient to exclude such company, unless the local authority should express its intention to undertake the supply and give evidence that it proposes to apply for permission to do so, and this should apply with more force when it can be shown that the exclusion of a company from such an area would injuriously affect the service of other contiguous areas.

(2) That in dealing with this question it should be considered as one affecting the interests of the metropolis as a whole, and as an area which at no very distant time may be for purposes of lighting and management of roads and streets under the control of one central authority; and that therefore the whole of the provisional orders granted for the metropolitan area should, as far as possible, be identical in form, with identical provisions as to supply, compulsory powers, interference with streets, and, more than all, as to price.

In my opinion the scheme adopted in 1883, of dividing the area of supply into two areas (A) and (B), would not be likely to work so much to the advantage of the public as the proposal in most of the orders under consideration to make the supply compulsory, under requisition, over the whole area upon equal terms.

I consider, however, that in order to insure that some work shall be at once undertaken in every parish or district within the area of supply under such order, there should be a list of streets scheduled for compulsory laying of mains, and a deposit made in every case where the local authority may wish to have it.

Where there are two companies in the same area, different streets should be scheduled for each.

With regard to the clauses affecting supply, interference with

* It is assumed, of course, that the Leyden jars from which the discharges occur are of uniform capacity in all the experiments.

streets, testing, position of stations and distributing boxes, and other details, the whole of the suggestions made by the local authorities should be carefully weighed. and those which are considered necessary embodied in the model form of order.

With regard to price, I do not consider that any one district in the metropolis should be put in a better position than another.

Taking the area as a whole, it does not appear that it would be wise to fix a lower *maximum* than 8d. per unit.

It it is true that the London company is now supplying at 7½d., and the *maximum* in the St. James's and Pall Mall Company's licence is 7d., but these companies are competing in an exceptionally good area.

There would, however, appear to be a necessity for a reduction of the high rate for *minimum* supply, that is, the sum which every customer taking a supply can be called upon to pay, irrespective of the amount which he has consumed, and which in the orders varies between £3 6s. 8d. per quarter in the case of the Notting Hill Company, and £5 10s. in the case of the Metropolitan Company's South London order.

The latter company has consented in the Mid-London and West London Orders to reduce the *minimum* to 13s. 4d. per quarter, and I consider that whatever *minimum* is fair should be adopted throughout.

The provision for revision of price after each seven years, in the agreements between the Metropolitan Company and the Strand and Marylebone local authorities, seems to me to be somewhat contrary to the policy of Parliament when dealing with the Electric Lighting Act. If any such provision be inserted it should be general; and it would appear to be more fair that the revision should take the form of a sliding scale upon the basis of a 10 per cent. dividend, the standard being fixed after the experience gained by the working of the first seven years.

It has been suggested that in the matter of price the consumer should, if he elects himself to pay the whole cost of connecting his house to the mains, have no *minimum* at all imposed upon him; but, although I can see no objection to this proposal, such a provision would hardly be necessary where the *minimum* is reduced as in the Metropolitan Orders.

(3) That in every case the supply of electricity, whether by a company or by a local authority, should be under statutory obligations as well as statutory powers, by means of a Bill, a Provisional Order, or a licence.

(4) That there is no objection to the granting of a large area of supply to any company which shows that it has sufficient capital and is capable of coping with the demand. On the contrary, a large and rich company is likely to be the best and most economically managed concern, to be able by working over a large and scattered area to develop the demand for the light, and by rapidly increasing its business to be the sooner in a position to reduce the price of the article supplied.

(5) That in the abstract competition is desirable, as tending to keep down the price, and to cause the manufacture and supply of electricity to be carried on with all the attention and energy which it is possible to devote to it.

The competition with gas, which at present at any rate, and probably for many years to come, will appeal to a totally different class of customer, will not be nearly so effective, while the potential competition from the power of calling in a new company in an area badly served is not likely to be called into play until the bad service has passed through many degrees, and has reached a very low ebb indeed.

The question as to how many companies should be granted concurrent powers in one area requires more consideration.

In cases where the local authority objects to the entrance of any company, and it is decided to overrule the objection, I think that one company only should be granted powers.

In cases where two or more companies have obtained the assent of the local authority, the following facts must not be lost sight of:—

1. That the laying of the mains of several companies up one street means so much dead capital, and moreover the provision of a certain amount of useless material, which the local authority would have to pay for if it shouid decide to purchase the undertakings after the lapse of 42 years.

2. That no matter what regulations or stipulations may be made as to the laying of mains, the interference with the streets, and the consequent inconvenience to the public, must be in a certain degree proportionate to the number of companies having powers over these streets.

For these reasons I am of opinion that, for the present, powers should not be given to more than two companies over the same area, and, inasmuch as the companies supplying under the alternating current and transformer system cannot supply electric energy capable of use for motors, that both these two companies should not be those using this system.

In order, therefore, to leave room for the entrance of a direct supply company into an area where two alternating current transformer companies have been assented to, it will be necessary to choose one only of these companies, and this will lead to a certain amount of districting.

(6) That wherever a company now supplying a district by means of overhead wires is granted an order for such area, it should be placed under the obligation to remove these overhead wires within a period of two years from the granting of the order; and, if such a thing be possible, that this company should be prevented from invading a district in which it has not got powers by means of overhead wires.

(7) That in order to reduce as much as possible the disturbance of streets, clauses should be drafted making it obligatory for companies to lay their mains in existing subways, and to transfer them into subways which may be made in the future, upon being called upon to do so.

If possible it would also be advisable to provide that, wherever circumstances admit of it, and where there is no subway, the conduits put down to lay the mains should be made capable of accommodating the mains of both companies in the area, if there be two companies having powers therein.

To a certain extent also it would appear to be right that the local authorities should have the power of objecting to the sites for generating, as distinguished from distributing stations, subject to an appeal to the Board of Trade.

Applying these principles to the orders asked for by the several companies, I recommend the Board of Trade to adopt the following course in each case:—

I. The London Electric Supply Corporation.—As this company and the Metropolitan Company are competing in many parishes and districts, and are both companies working with alternating currents, unable at the present time to provide for motive power, the areas applied for should be districted, and I propose, therefore, to allot to the London companies and to include in the London order the following parishes and districts:—

The portion of St. Martin-in-the-Fields lying to the south of the Strand and west of St. Martin's Lane; the portion of St. Margaret and St. John, Westminster, lying to the north of Victoria Street, excepting that portion of St. Margaret's lying to the west of St. George, Hanover Square; St. James, Westminster; St. George, Hanover Square; Chelsea; the Greenwich district; St. Mary, Rotherhithe; St. Mary, Bermondsey; the district of St. Olave; the district of St. Saviour, Christchurch; and that portion of St. Mary, Lambeth, lying to the north of Westminster Bridge Road.

The only dissenting local authorities in the above areas are the vestries of St. James, Westminster, of St. Mary, Lambeth, and of St. Margaret and St. John, Westminster, and the District Board of St. Saviour's, but of these the first two would, judging from the statements of their representatives at the inquiry, consent, if their objections be, in the opinion of the Board of Trade, fairly met; and it should be pointed out to them that while St. James's would under the terms of the order gain by the compulsory removal of the overhead wires with which the London Company is at present largely supplying in the parish, it is in the case of St. Mary, Lambeth, essential to the continuity of the London Company's area that this company should have the means of passing through the northern end of the parish.

This last reason applies equally to the parishes of St. Margaret and St. John, and the opposition of the united vestry of these parishes was not so strong as to lead to the belief that it would object to the division of the parishes as I propose between two companies, especially as there appears to be a demand for electricity in the district.

The district of St. Saviour's, after assenting to the granting of the order, withdrew the assent, but did not appear at the inquiry to give any reasons for so doing, and as the district intervenes between other portions of the London area, the local authorities of which have assented and wish for the supply of electric light, I submit that the objection of St. Saviour should be overruled.

The case of St. James and St. John, Clerkenwell, is difficult to deal with. This parish is cut off from the district which I propose to allot to the London Company, and the Metropolitan Company has abandoned the North London order, in which it was included, while the vestry has assented to the entrance of both companies.

If the City should consent to allot a district to the London Company, giving access to Clerkenwell, this parish should be added to the London area, otherwise it might be suggested to the Metropolitan Company to adhere to their North London order so far as this parish is concerned.

The general form of the clauses of the order should be similar to those in the other orders for the metropolitan area, and it will be better to deal with all the suggestions and requirements of the local authorities on this head generally, when the principles upon which the orders are to be granted have been considered and determined, but there are two special clauses in the London order, which have already been alluded to, and might be dealt with separately.

I do not see any objection to Clause 55, authorising the supply to a local authority of electricity in bulk, provided, in the opinion of the legal authorities, it be possible to place the local authorities under the obligations of the order by any such clause.

As to Clause 56 I think that, subject to the sub-division of the generating station at Deptford, as recommended on page 19 of this report, it would be a mistake to reduce the cubical dimensions of the building.

A compliance with the recommendations on the above-mentioned page should be a condition upon which the granting of the order should depend.

II. The Metropolitan Company.—To this company I would recommend that the following area should be allotted:—

Under the Mid-London Order.—St. Giles-in-the-Fields; St. George, Bloomsbury; St. Andrew, Holborn-above-Bars; St. George the Martyr; St. Sepulchre, Saffron Hill; Hatton Garden; Ely Rents and Ely Place; the Liberty of Glasshouse Yard; St. Ann's, Soho; St. Paul, Covent Garden; St. John the Baptist; Savoy or precincts of Savoy; St. Mary-le-Strand; St. Clement

Danes and the Liberty of the Rolls; together with the extra-parochial places known as the Charterhouse, Gray's Inn, Lincoln's Inn, Staple Inn, and Furnival's Inn.

The whole of the local authorities in the above area assent to the order.

Under the West London Order.—St. Marylebone, the vestry of which assents to the order.

Under the South London Order.—St. Mary, Lambeth, St. Leonard, Streatham; and Clapham.

Neither of the local authorities affected—viz., the Vestry of St. Mary, Lambeth, and the Wandsworth District Board—has signified its assent, but both would probably do so if their objections be met in a manner considered fair by the Board of Trade.

Under the Bill.—That portion of St. Martin-in-the-Fields which lies to the east of Northumberland Avenue, Charing Cross, and St. Martin's Lane.

The vestry of St. Martin-in-the-Fields assents to the Bill.

With powers in this area, the Metropolitan Company will have access from the main portion of the Strand district to the outlying portions, and will also have powers over some portion of the parish of St. Martin-in-the-Fields, contiguous to their existing station in Whitehall. In the latter portion, although the company will be competing with the London Company, there will not be two alternating current companies, as the supply from the Whitehall station is by continuous current.

The only area in which there will be two competing alternating current companies is in North Lambeth, where it cannot well be avoided.

III. The House-to-House Company. IV. The Notting Hill Company.—I recommend that the areas as agreed to between these companies and the Vestry of Kensington be approved of and the orders granted in suitable terms.

V. The Kensington and Knightsbridge Company.—Similarly in the case of this company, I recommend that the area as agreed to between the Company and the Vestry of Kensington be approved of and the order granted.

With regard to the part of the parish of St. Margaret, Westminster, applied for, I recommend that the order be approved of, subject to the consent of the vestry. This body has decided to object to the powers which are being exercised under licences granted by consent being extended to those given by Provisional Order; but I trust that the matter may be so represented that this decision may, on reconsideration, be altered.

VI. The Chelsea Company, South Kensington Order.—This order is assented to by the vestry of Kensington, and I recommend that it be granted for the area agreed to.

Belgravia Order.—In the case of this order I see no valid reason for dispensing with the consent of the vestry, which has been withheld. Consent has been given to the orders of three other companies.

VII. The Westminster Company.—Although the scheme of this company is in a somewhat inchoate condition, the vestry of St. George's, Hanover Square, has assented to the order. The vestry of St. Margaret and St. John, Westminster, withholds consent; but, for reasons already given, I consider that powers over part of the area asked for in this district should be given, the existing station of the company being in this area.

I recommend that the order be granted for the parish of St. George, Hanover Square, and the portions of St. Margaret and St. John, Westminster, lying to the South of Victoria Street.

This company has abandoned the remainder of the area originally applied for.

VIII. The Electrical Power Storage Company. Paddington Order.—In view of the objection of the vestry, and its expressed intention to undertake the lighting of the parish, and for other reasons given below, I cannot recommend that this order be granted.

St. Martin's and Strand Order.—The vestry of St. Martin's assents and the Strand District Board dissent to the order.

The company applying for these orders is a company manufacturing batteries and other electrical appliances, and it seems more than doubtful whether, under the articles of association, there is any power to undertake the manufacture and supply of electricity for house-to-house lighting purposes. However this may be, it is perfectly clear from the evidence of the manager of the company that the company does not intend to exercise the powers which would be granted by the order, but to transfer them to some other persons.

I have no doubt that these persons are perfectly willing and competent to carry out the powers and obligations of the order, but I submit that it would be quite contrary to practice to grant an order to any but a properly constituted company, proved to be in a position to act under it, and as this has not been done, I cannot recommend that the order be granted.

It should be understood that in every case the recommendations to grant these orders is on the understanding that the whole of the works both at the generating and other stations, and along the mains, are to be planned and executed in a manner such as to satisfy the Board of Trade that the public are properly protected, both as regards safety, and, so far as may be possible, from any extinction of the light for an appreciable time, and that, should it be found impracticable to carry out the districting between the London and Metropolitan Companies in the manner which I have proposed, the whole question will be reconsidered so that the areas may be fairly readjusted.

The Metropolitan Orders for the Strand and Marylebone should be in as nearly as possible the same form as those applying to other parts of the metropolis, as there does not appear to be any sufficient reason for treating these areas differently from any others.

The only districts applied for in which I have decided not to recommend the granting of orders, as amended, are the parishes of St. Pancras and Paddington, where the local authorities should, I think, be granted time to decide definitely whether or not to carry out the lighting of their parishes under the powers of a Provisional Order; and the City, which, although not exempted from the operation of the Electric Lighting Acts, is in a somewhat different position from other parts of the metropolis.

The Commissioners of Sewers, acting for the Corporation, are endeavouring to obtain tenders for the lighting of the City, but I see no reason why the principle that all such lighting should be done under statutory powers and obligations should be departed from in their case.

If the Board of Trade should agree in this view, I would urge the Commissioners of Sewers to consider whether the orders, as remodelled, do not sufficiently provide for all their requirements, and in that case to consent to the division of the area of the City between the two competing companies—viz., the London and the Metropolitan companies, the latter company being allotted the portion nearest to the Strand district, and the former the central and eastern portions of the City, so that access may be given to the parish of Clerkenwell, the vestry of which wishes for an order to be granted to this company.

In addition to the above-mentioned Provisional Orders, the two licences applied for by the Chelsea Company and the House-to-House Company have to be considered. These licences are both for areas included in the portions of the parish of Kensington allotted to the companies respectively by the vestry, and the consent of the vestry has been given.

Subject to any alterations in clauses which may be found necessary to make the provisions of these licences similar to those of the Provisional Orders applied for, I can recommend that, for the purpose of expediting the commencement of the works, they be granted.

I have the honour to be, Sir, your obedient servant,

F. A. MARINDIN, Major, R.E.

I concur with the above report,

P. CARDEW, Major, R.E.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.—May 16th, 1889.

Continuation of discussion on Dr. Lodge's paper on "Lightning, Lightning Conductors, and Lightning Protectors." (*Authorised abstract.*)

Mr. WIMSHURST, on resuming the discussion, reperformed his experiments on the difference in the protective power of points when the clouds are positive or negative, and said that in the latter case the point might be 2¼ to 2½ times as far away from the cloud as a dome, and still protect. The reversal of the direction of the "*b* spark" by putting in a "bye pass" was also shown, together with experiments indicating that imperfect earth greatly increases the tendency to side flash, and that this tendency is further increased by augmenting the size of the body receiving the flash, and by connecting it to earth. In view of these facts the experimenter considered that the conclusions of Dr. Lodge respecting the small importance of good earth, and the propriety of connecting all pieces of metal together and to the earth, needed reconsideration. Side flashes were also taken by Leyden jars, and in some cases they were found uncharged when tested, whilst in others the charge remained. An experiment analogous to the sparking seen on the gilding of the walls during Dr. Lodge's experiments was next shown, in which sparks passed between separate pieces of foil forming a spangled outer coating of a Leyden jar, when an insulated body within the jar was connected to an influence machine at work.

Prof. HUGHES said he did not agree with Dr. Lodge's statement that the "older electricians" never contemplated "case *b*," for Sir W. Snow Harris had recognised the difference, and from experiments made by Prof. Guillemin, M. Bertsch and himself in an investigation on lightning protectors (see *Annales Telegraphique*, 1865, and *Electrician*, July 13th, 1888), it was concluded that Leyden jar discharges differed from ordinary lightning, for it was well known that protectors did protect instruments, whereas in their experiments with large jars nothing protected them. He also considered it unfair of Dr. Lodge to take all the credit of having recognised the distinction between cases, *a* and *b*, and the influence of self-induction, to himself, altogether ignoring his predecessors in the field, for Prof. Guillemin showed that a sheet of tinfoil might protect an iron wire, whereas the same foil rolled up like a wire failed to protect. As regards iron *v.* copper his (Prof. Hughes's) experiments prove that for rapidly varying voltaic currents copper is decidedly superior, and the preference now given to copper for telegraphic and telephonic work points to the same conclusion. It had also been shown that iron wire was circularly magnetised by discharging a Leyden jar through it, and the production of this effect would, he considered, retard the discharge.

Mr. G. J. SYMONS thought that Dr. Lodge did not realise the alarming nature of his own remarks in reference to the Rules of

the Lightning Rod Conference. As a member of that body he was anxious to improve the rules wherever possible, but considered it injudicious to discard well tried and safe rules until something better had been devised and tested by experience. As regards points *v.* knobs, the subject had been thrashed out 120 years ago. The Lightning Rod Conference had recognised the importance of hot air currents, for they recommended that house conductors should be fixed to the kitchen chimneys. The dimensions of conductors was next referred to, and from the fact of large ones having been fused the speaker thought Mr. Preece should not recommend small wire. He also stated that although the existence of a "protected area" around a conductor was disputed, yet much evidence pointed in that direction.

Colonel ARMSTRONG, R.E., speaking of the protection of magazines, said he believed the War Office were the only body who had regular and systematic earth resistance tests made on their conductors. From his experience in the matter he could say that no accident had ever happened to a magazine whose conductors made good earth, as shown by the regular tests, whereas several had occurred in cases where the earth was bad (say 200 ohms). In one case the conductor was fused below the point at which the main flash left the conductor, and this he believed due to want of continuity at the lower place. In another case, cartridges packed in a sealed metal case were exploded by a lightning flash, thus showing that currents were not confined entirely to the outer layers, as Dr. Lodge supposes.

Mr. A. J. S. ADAMS considered wires carrying varying currents to be under stress, and that such stress was relieved by radiation from the wire. The amount of this so-called radiation he takes to be a measure of the opposition offered to the passage of the current, and says that copper radiates about 25 per cent. less than iron or brass.

Mr. SPAGNOLETTI said telegraph wires were very seldom fused, although instruments were frequently damaged, and as an instance of such wires conveying large lightning currents cited a case in which a lineman was killed by touching a wire which was struck by lightning at a point 50 miles away. He also asked whether lightning flashes had been proved to be oscillatory?

Mr. S. EVERSHED described some observations he made in 1877 which tend to show that the "*b* spark" does occur in nature. A thunderstorm was in progress about five miles from his place of observation, where he had a gold leaf electroscope and a quadrant electrometer connected to an insulated plate about 6 feet high. In the intervals between the flashes the leaves remained open about $\frac{1}{8}$th inch, but instantaneously with each flash they opened to three times that amount. The spot of light from his electrometer disappeared with such rapidity that he could never say in which direction it moved. These facts also show that "Nature" is not always "slow and solemn," as Mr. Preece would have us suppose; and the peculiar effects exhibited at Antwerp railway station prove that lightning does not always behave in accordance with the views of the Lightning Rod Conference. Referring to Mr. Preece's supposed proofs from telegraphic records that flashes are not oscillatory, Mr. Evershed pointed out that such records would be produced even if oscillations were present, for a greater quantity of electricity passes in one direction than in the other.

The PRESIDENT (Sir W. Thomson), in closing the discussion, thought Dr. Lodge's paper a most interesting and valuable one, and the institution was greatly indebted to its author for bringing the matter so prominently forward. All admit that the importance of self-induction was not sufficiently recognised previously. He could not say whether Franklin knew of its existence, but Sir W. Snow-Harris did, and many views held by the latter, which until recently, were condemned, have now been proved correct. Referring to section 56 in the paper, he thought Dr. Lodge did not mean what was there stated as to the shape of section of the conductor, for it was quite certain that flat ribbon had much less self-induction than round rod. As regards gas and water pipes as earth, Sir William considered that they made a good earth, and he did not see much danger in connecting pieces of metal with the lightning conductor in cases where other earth could be obtained. In view of Colonel Armstrong's statement about cartridges being exploded when completely enclosed in metal casings, he thought it important to try if iron cases afforded more protection than brass or copper ones, for it was probable that the magnetisation of the iron by the currents would produce additional screening. Faraday's electric cage experiment should also be repeated, using the more sensitive apparatus since devised to seach for any internal effect. In conclusion, the President said the report of the Lightning Rod Conference is a very important work, and though some flaws may exist, yet on the whole, experience gives very strong reasons for believing that the rules are good.

Physical Society, May 11th, 1889.

Prof. REINOLD, President, in the Chair.

Mr. A. Clegg, Prof. V. B. Lewis and Mr. W. Robinson were elected members of the Society.

The following communications were read:—"On an Electrostatic Field produced by varying Magnetic Induction," by Dr. O. J. LODGE, F.R.S. This paper describes a research made with the object of finding some connection between static electricity and magnetism. Several methods of attacking the problem, such as rotating or varying the strength of magnets in the neighbourhood of delicately suspended charged bodies, are indicated, and the one selected was based on an idea of Mr. A. P. Chattock, who conceived that a charged body in the vicinity of a closed magnetic circuit would be affected by varying the magnetic induction. From the theory of the effect it is shown that the magnitude of the quantity sought is exceedingly small, for the expression involves the inverse square of the velocity of light. The E.M.F. induced in any closed curve round the magnetic circuit or solenoid by varying the induction, I, is given by

$$e = \frac{d\,\mathrm{I}}{d\,t}. \qquad (1)$$

If an E.M.F., e, act on a charge, Q, at distance, r, from the axis of the solenoid, the work done in one revolution will be $e\,\mathrm{Q}$, and

$$e\,\mathrm{Q} = \mathrm{F} \,.\, 2\,\pi\,r \qquad (2)$$

where F is the mechanical force. Now if the E.M.F. in (1) is the same as that in (2), the impulse given to the charged body by destroying the induction will be

$$\phi = \int_0^\infty \mathrm{F}\,d\,t = \frac{\mathrm{I}\,\mathrm{Q}}{2\,\pi\,r} \qquad (3)$$

Since $$\mathrm{I} = \frac{4\,\pi\,n\,\mathrm{C}\,\mathrm{A}\,\mu}{l} = \mu\,\mathrm{c} \text{ times a length,}$$

and $$\mathrm{Q} = s\,\mathrm{V} = \mathrm{K}\,\mathrm{V} \text{ times a length.}$$

$$\therefore\quad \phi = \frac{\mathrm{K}\,\mu\,e\,\mathrm{V}\,\mathrm{A}}{2\,\pi\,r}\ (\text{length})^2 \quad \text{and } \mathrm{K}\,\mu = \frac{1}{a_v{}^2}. \quad \therefore\ \phi \propto \frac{1}{a_v{}^2}.$$

The magnetic circuit actually used was a wire gramme ring of trapezoidal section wound with copper over only a part of its periphery. The indicating apparatus was a suspended needle consisting of two oppositely charged bodies carried on a small shellac arm, to which a mirror or pointer was attached, and was suspended vertically in the plane of the ring. Great difficulty was experienced from Foucault currents when metallic films were used for the needle, and the magnetic properties of other semiconductors tried further complicated the matter. Eventually the charged bodies were made of paper in the form of cylinders $\frac{1}{16}$th inch diameter and $\frac{3}{16}$ths inch long. Considerable trouble was caused by the electrostatic action between the needle and exciting coils, and various methods of screening were tried and abandoned, and subsequently the wire was replaced by a single spiral of copper ribbon, the outer turn of which was put to earth. Observation was rendered difficult owing to the wandering of the zero when the needle was charged, but this was minimised by suitably shaping the contour of the needle's surroundings. Heat also created considerable disturbance, and the convection currents were cut off by a series of concentric cylinders of tin plate. The method of observation was to charge the two insulated parts of the needle and then reverse the magnetising current in synchronism with the period of the needle, noting whether the amplitude of any residual swing could be increased or diminished according as the impulse assisted or opposed the motion. In this way slight indications have been observed, and the effects reverse when the charges of the cylinders are reversed. In explaining the theory of the experiment, the author made use of a simple transformer consisting of an ordinary hank of iron wire wound over with insulated copper and provided with several secondary coils; and by it he demonstrated that the primary current increases on closing the secondary, due, as was shown, to the decrease of self-induction of the primary caused thereby.

Prof. FITZGERALD, in answer to a question from Dr. Lodge as to the influence of screens, said he had not fully considered the matter in this particular case, and as the general effect of screens depended on the square of "v," the subject required careful treatment. As a means of checking the results obtained by Dr. Lodge, he suggested calculating the impulse, and seeing whether its magnitude approximately corresponds with that observed. Commenting on an idea for carrying out a similar experiment attributed to him in the paper, in which a charged gold leaf is placed between the poles of a magnet, Prof. Fitzgerald said he had been misunderstood, for he had conceived a disc parallel to the faces of the magnets which, when excited, should cause the disc to turn in its own plane. Referring to the equations for mechanical force given in Maxwell, section 619, he pointed out that the coefficient of e in the equation

$$\mathrm{X} = e\,v - b\,w - e\,\frac{d\,\Psi}{d\,x} - m\,\frac{d\,\Omega}{d\,x}$$

ought to be P, where

$$\mathrm{P} = c\,y - b\,z - \frac{d\,\mathrm{F}}{d\,t} - \frac{d\,\Psi}{d\,x}$$

and considered it very important that the existence of the term $e\,\frac{d\,\mathrm{F}}{d\,t}$ should be tested experimentally.

Prof. S. P. THOMPSON mentioned some experiments on which he was engaged, by which he hoped to show electric displacement in continuous dielectric circuits, such as a hank of gutta-percha. Up to the present the experiments had not been successful, owing to his inability to place the two gramme ring coils used into such relative positions as to give silence in the telephone connected with the coil used as secondary, when currents were sent through the primary.

Prof. AYRTON suggested that Dr. Thompson's difficulty may arise from the fact that such rings do produce considerable external field even when carefully wound.

Prof. FITZGERALD requested Dr. Thompson to investigate the

effects of displacement currents and of changing vector potential, and pointed out that in a single medium the former can produce no magnetic effect. As regards fields containing different media, he said the calculations would be complicated by the spurious charges on the separating surfaces.

Dr. LODGE, in reply, said he had calculated the momentum to be expected in one arrangement of his experiment in which a suspended aluminium cylinder surrounds one limb of a rectangular magnetic circuit which formed the core of an induction coil; one end of the secondary was put to the core and the other to the cylinder, thus forming a condenser. The result came out about 10^{-6} dyne second, but he could not say whether such a small quantity was observable.

"On the Concentration of Electric Radiation by Lenses." by Prof. O. J. LODGE, D.Sc., F.R.S., and JAMES L. HOWARD, D.Sc. The authors' first attempts at concentration were made with mirrors on a comparatively small scale, and owing to the difficulties experienced it was considered desirable to try lenses. Two large cylindrical ones of plano hyperbolic section were cast of mineral pitch in zinc moulds, the plane faces being nearly a metre square, the thickness at vertex 21 centimetres, and each lens weighed about 3 cwt. The eccentricity of the hyperbola was made 1·7 to approximate to the index of refraction of the substance. The lenses were mounted about 6 feet apart with their plane faces parallel and towards each other on a table in the college corridor, and an oscillator was placed about the principal focal line of one of them at a distance of 51 centimetres from the vertex. The field was explored by a linear receiver made out of two pieces of copper wire mounted in line on a piece of wood, and the air gap between their inner ends was adjustable by a screw. When the oscillator worked satisfactorily, the receiver would respond to about 120 centimetres, and with the lenses the distance was 450. The receiver responded anywhere between the lenses and within the wedge between the second lens and its focal line, the boundaries being clearly defined, but no special concentration was noticed about the focus. Interference experiments were carried out by placing a sheet of metal against the flat face of the second lens, and determining the positions of minimum intensity between the lenses. The distance between these points was 50·5 centimetres corresponding with a wave length of 101 centimetres, whereas the calculated wave length of the oscillator was 100 centimetres.

Prof. FITZGERALD congratulated the authors on their success, and also pointed out that although large oscillators give good results at distances within a few wave lengths, yet at greater distances small ones were decidedly superior, owing to the energy of radiation varying as the fourth power of the rapidity. He had recently made experiments on electric radiations analogous to Newton's rings, and had successfully observed the central dark spot and the first dark band. Referring to Dr. Lodge's experiments, he enquired whether any traces of diffraction were observed near the boundary of the bundle of rays between the lenses. Speaking of polarisation experiments, Prof. FitzGerald said waves reflected from films of water exhibited no polarisation, whereas those reflected from non-conductors were completely polarised.

In reply, Dr. LODGE said no diffraction effects had been observed, but in the interference experiments to determine wave length, the positions of minimum effect were very decided.

The PRESIDENT, in proposing that the thanks of the meeting be given to the authors of the papers, congratulated the society on the presence of both Dr. Lodge and Prof. FitzGerald on the present occasion, when subjects with which they were so well acquainted were brought before the meeting.

NEW PATENTS—1889.

7526. "An automatic compensating feed electric arc lamp." A. U. ALCOCK and H. GALOPIN. Dated May 6. (*Complete.*)

7600. "Improvements in electric indicators." B. C. C. CANT. Dated May 7.

7613. "A new boat, which shall be here called 'The over-water boat, for steam, hot air, electric, or any other motive power or mode of propulsion.'" S. PRICE and C. A. SODERBERG. Dated May 7.

7619. "Improvements in and connected with electric batteries." W. J. S. BARBER-STARKEY. Dated May 7.

7645. "Improvements in underground conduits for electrical conductors." G. W. COOK. Dated May 7. (*Complete.*)

7647. "Improvements in electric motors and dynamo-electric machines." S. S. WHEELER. Dated May 7. (*Complete.*)

7673. "Improvements in electric wire insulators." A. W. HEAVISIDE. Dated May 8. (*Complete.*)

7719. "Improvements in electric or galvanic elements or cells." P. SCHOOP. Dated May 8.

7773. "Improvements in means for actuating signals, switches, and gates on electric and other railways. R. C. SAYER. Dated May 4, 1889. [NOTE.—This No. *cancels* No. 3487A in No. 18 of this Journal.]

7774. "Improvements in means for supplying electric current to road vehicles, boats, and the like." R. C. SAYER. Dated May 4, 1889. [NOTE.—This No. *cancels* No. 3487B in No. 18 of this Journal.]

7778. "Improvements in the process of and apparatus for reducing aluminium, its alloys, and other metals from their ores." F. F. JONES. Dated May 9.

7780. "An electrical-firing apparatus for ordnance." R. MORRIS. Dated May 9.

7860. "Improvements in holders for electric incandescent lamps." S. PITT. (Communicated by C. Lemon, New Zealand). Dated May 10.

7868. "Improvements in electric meters." W. EMMOTT and W. ACKROYD. Dated May 11.

7870. "An improved electric generator." J. GOZO. Dated May 11.

7883. "Improvements in electro-motors and apparatus used therewith for dental and other purposes." T. CUTTRISS. Dated May 11.

7894. "Improvements in the method of distributing electricity by means of alternating currents." L. B. ATKINSON. Dated May 11.

7895. "Improvements in dynamos, motors, and motor-generators for use with alternating currents." L. B. ATKINSON. Dated May 11.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888

4626. "Improvements in the electrolytic production of metals." C. HOEPFNER. Dated March 26. 6d. Relates to processes for obtaining metals, in particular copper, by electrolysis, whereby a greater yield of metal is obtained with a much smaller expenditure of precipitating iron or of electrical power employed for effecting the precipation, than with the processes now employed. These advantages are mainly obtained by producing and employing the copper protoxide salts in place of the copper oxide salts heretofore used for electrolysis. The claims are 3 in number.

4819. "Battery for general electro-medical use or as electrical dumb bells, Indian clubs and the like for muscular exercise, with electrical current of any desired strength during such exercise." W. G. JOHNSON. Dated March 29. 8d. Relates to a special construction or arrangement of electrical battery contained within and forming one of a pair of dumb bells, or said battery may be in the handle of an Indian club, or other muscular exercising appliance of a similar character, the other dumb bell or handle constituting the pair serving as the conductor for completion of circuit when a wire is connected, which wire may be of any desired length and thrown over the shoulder of the user so as not to be in the way during his exercises. The claims are 2 in number.

4844. "Improvements in or relating to holders for incandescent electric lamps by which they are made applicable as combined holders and circuit closers and breakers." W. P. THOMPSON. (A communication from abroad by N. E. Garczynski, of Paris.) Dated March 31. 8d. Relates to a holder for incandescent lamps of a simple, solid and cheap construction, and can be made so as to be adapted to any kind of incandescent lamp now in use; it is, moreover, arranged so as to satisfy completely the various conditions required to insure the perfect working of these lamps, namely :—1. The proper working of the contacts by means of springs which can be regulated without taking the apparatus to pieces. 2. The springs not being used as conductors are not liable to get heated. 3. The manipulation of a lever or key brings the movable contacts a good way apart; this being easily effected by hand or at a distance. 4. The taking to pieces of the apparatus, the renewal of any of the parts, and the fixing of the conducting wires thereto, are done with the greatest ease. 5, and lastly, the omission of the interrupting mechanism, if desired, admits of the apparatus being utilised as an ordinary lamp holder. The claims are 3 in number.

5848. "An apparatus for performing operations at intervals, applicable to the making of electric contacts or for analogous uses." H. EDMUNDS. Dated April 19. 8d. Claims:—1. A timekeeping device, consisting of a circular series of compartments or chambers, with passages for liquid from one to the other, and capable of revolving on a fixed axis or in fixed bearings in combination with a weight or spring, substantially as described. 2. A timekeeping device or regulator, consisting of a closed hollow drum divided into chambers or cells connected by openings to each other, partially filled with liquid, and capable of oscillating or rotating on fixed centres or fixed bearings, and arranged in combination with motive mechanism to operate at regular intervals mechanical or electro-mechanical apparatus, substantially as described and illustrated in the drawings.

6046. "Improved jointer or coupling for electrical conductors." R. VON FISCHER TREUENFELD. Dated April 23. 8d. The inventor forms the two ends of the conductors that are to be jointed together with a tapering enlargement which may be conveniently formed by bending over the ends of the wire or wires, and after soldering together the bend, filing it to the required tapering enlarged form. These enlarged ends are then secured in correspondingly tapered holes in a metal jointing piece or coupling. The claims are 2 in number.